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TOUCH-TONE DECODER

Display dialed digits on an LCD readout!

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The Fluke 79: More Of A Good Thing

More high-performance features. More advanced measurement capabilities. More of the vital information you need to troubleshoot even the toughest problems — with both analog and digital displays.

Meet the latest, greatest member of our best selling 70 Series II family — the new Fluke 79 digital multimeter.

It picks up where the original family left off. In fact, it's a quantum leap forward — in performance, value and affordability.

It's got the features you'd expect from Fluke. Including high resolution. Fast autoranging. Patented, automatic Touch Hold®. A quick continuity beeper. Diode test. Automatic self-test. Battery-conserving sleep mode. And it's just as rugged and reliable as the rest of the 70 Series II family. Easy to operate, too — with one hand.

And thanks to the Fluke 79's proprietary new integrated circuit technology, that's only the beginning. When it comes to zeroing in on tough electrical problems, the Fluke 79 leaves the competition behind:

Hz

Frequency: The Fluke 79's built-in frequency counter lets you measure from below 1 Hz to over 20 kHz. And while you view frequency on the digital display, the analog bar graph shows you AC voltage. So you can see if potentially hazardous voltage is present.

Fast 63-segment analog bar graph: The Fluke 79's bargraph moves as fast as the eye can see, updating at a rate of 40 times per second to simulate the functionality of an analog needle. You get the high speed *and* high resolution you need to detect peaking, nulling and trending.

Capacitance: No need to carry a separate dedicated capacitance tester; the Fluke 79 measures capacitance from 10 pF to 9999 µF.

FLUKE 79 SERIES II MULTIMETER
8.8.8.8
H nµF
mV AC
mV DC
Mk Ω Hz
0 1 2 3 4 0
mV
OFF
Ṽ H
Hz
V H
mV H
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40Ω
PRESS
RANGE
AUTORANGE, 40Ω
1 SEC
H (TOUCH HOLD)
2 SEC
10A
40 mA
VΩ
1000V
750V
COM
FUSED

Actual Size

40Ω

Lo-Ohms range: Our proprietary Lo-Ohms function lets you measure resistance as low as 0.01 ohms. High noise rejection and a test lead Zero Calibration function make the Fluke 79 ideal for detecting small resistance changes.

SMOOTHING

Smoothing™: Our exclusive new Smoothing mode gives you a stable digital readout for unstable signals — by displaying the running average of eight readings. No more jitter or "digit rattle" due to noisy signals.

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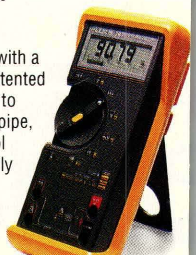

The Fluke 79 comes with a yellow holster and patented Flex-Stand™ — easy to hang from a door or pipe, clip onto a belt or tool kit, or stand at virtually any viewing angle. There's even storage space for test leads.

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$185*
4000 Count Digital Display (9999 in Hz, capacitance, and Lo-Ohms)
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0.3% Basic DC Voltage Accuracy
Automatic Touch Hold
Diode Test, Audible Continuity Beeper
Autoranging, Manual Ranging
Holster with Flex-Stand
Frequency Counter to over 20 kHz
Capacitance, 10 pF to 9999 µF
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Smoothing
700 Hours Battery Life (alkaline)
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Vol. 64 No. 11

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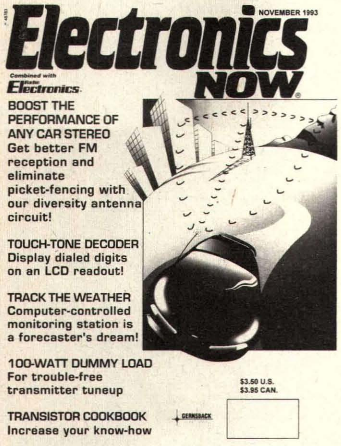

BOOST THE PERFORMANCE OF ANY CAR STEREO
Get better FM reception and eliminate picket-fencing with our diversity antenna circuit!

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Display dialed digits on an LCD readout!

TRACK THE WEATHER
Computer-controlled monitoring station is a forecaster's dream!

100-WATT DUMMY LOAD
For trouble-free transmitter tuneup

TRANSISTOR COOKBOOK
Increase your know-how

How often do you see cars inching forward while waiting for a red light to change? It could mean that the driver is an impatient type. But it's just as likely that he's trying to find a better spot for FM radio listening. Those annoying bursts of interference, which also occur while the car is in motion, can be caused by local sources of interference, or by multipath noise—audible "ghosts" that arise when radio waves traveling over paths of different lengths converge on your antenna. You can eliminate the effects of multipath noise, without moving your car, with our Diversity Antenna. The circuit automatically switches between your car's original antenna and a second antenna, depending on which one is positioned for the best reception. For all the details, turn to page 31.

WEATHER STATION

Here comes the rain—let's make sure our weather station is ready for it.

RONALD M. JACKSON

IN LAST MONTH'S ARTICLE, CONSTRUCTION details for an anemometer, wind vane, and rain gauge were described. Now it's time to build the sensors to measure temperature and humidity and complete the weather station. Experimenter's connections to your computer were described in **Electronics Now**, July and August 1993. This month the weather station's connections to the Experimenter are described.

Air sensors

"It's not the heat, it's the humidity." Although sometimes it's both! But in either case, the weather station has the data you need. Five temperature sensors, with tenth-of-a-degree resolution, provide accurate temperature information. You can place one indoors, one outdoors, one upstairs, one downstairs, and one, perhaps, in the attic or deep freezer.

Two humidity sensors provide inside and outside relative humidity information, with 1% resolution. You might use the information to calculate the heat index, or to monitor conditions in a greenhouse.

Changes in barometric pressure are generally the most useful weather prediction indicators. A falling pressure trend usually means that stormy weather is on the way, while a rising trend portends sunshine. The weather station uses a solid-state pressure sensor to make accurate, stable, high-resolution barometric pressure measurements. Although not possible with the "freeware" program, a professional version of the software permits all weather data to be stored on your computer's hard disk. Graphing features make it easy to see and interpret pressure trends.

The signal-conditioning electronics for the temperature and humidity sensors can be wired point-to-point in the wiring grid area on the Experimenter board. With a tight layout, all of the components will fit on the board. However, be aware that every fourth pad on the top and bottom rows of the wiring grid are connected to +5 volts and ground, respectively. Those pads are convenient for supplying power to logic ICs, which have power and ground connections in the standard locations of upper right and lower left. But you must be careful to avoid inadvertent connections to +5 volts and ground when wiring other circuitry.

As an alternative to point-to-point wiring, you can make your own signal-conditioning board using the foil patterns provided here. A high-quality PC board is also available from the source given in the Parts List.

Signal-conditioning board

None of the meteorological sensors connect directly to the Experimenter. They all require some signal conditioning from the circuitry shown in Fig. 1. The op-amps, RC filters, and digital prescalers prepare the outputs of various sensors so that the Experimenter can measure them with maximum accuracy. If your Experimenter

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DTMF DECODER

Scanner users: here's an inexpensive way to decode DTMF tones that you hear.

FRANK HAMPSHIRE

HAVE YOU EVER BEEN CURIOUS about the dual-tone multifrequency (DTMF) tones heard on your scanner or amateur-band receiver? The circuit discussed here will decode DTMF tones and display them on a liquid crystal display, so that you can get a better understanding of the action on the radio bands.

The unit has a memory capacity of 64 digits, yet the cost of building this project is one-third to one-half of comparable commercially available instruments.

Hardware

The circuit consists of three major components: a microcontroller, a DTMF decoder IC, and an LCD display module. The microcontroller, a Motorola 68705P3, is packaged in a 28-pin DIP, and contains 1804 bytes of EPROM, 112 bytes of RAM, 2 bi-directional 8-bit ports, and a bi-directional 4-bit port. Software for the microcontroller will be posted on the *Electronics Now BBS*. The 68705 microcontroller was discussed in the September and October 1989 issues of **Radio-Electronics**.

The DTMF receiver/decoder, a Silicon Systems 75T-202, requires a 5-volt power supply and a 3.579545-MHz colorburst crystal. It will decode all 16 Touch-Tone frequency pairs. The display, an Optrex DMC16101A sixteen-by-one LCD module, was covered in the June and July 1990 issues of **Radio-Electronics**. The module makes it very easy to display alphanumeric characters because it has a built-in controller that handles all conversion details.

How it works

The schematic for the DTMF decoder is shown in Fig. 1. Software configures all 8 bits of Port A (pins 20–27) of the microcontroller as outputs, which drive D0–D7 of the LCD module. Port B of the microcontroller

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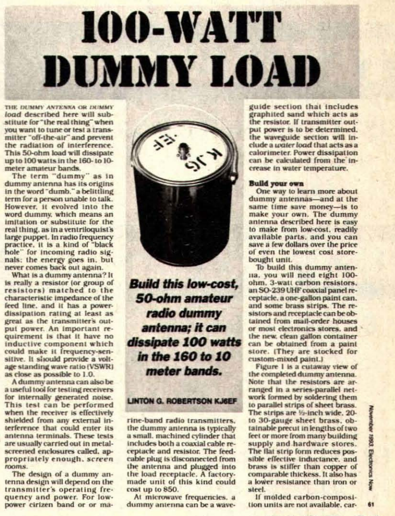

100-WATT DUMMY LOAD

Build this low-cost, 50-ohm amateur radio dummy antenna; it can dissipate 100 watts in the 160 to 10 meter bands.

LINTON G. ROBERTSON KJ6EF

THE *DUMMY ANTENNA* OR *DUMMY load* described here will substitute for "the real thing" when you want to tune or test a transmitter "off-the-air" and prevent the radiation of interference. This 50-ohm load will dissipate up to 100 watts in the 160- to 10-meter amateur bands.

The term "dummy" as in dummy antenna has its origins in the word "dumb," a belittling term for a person unable to talk. However, it evolved into the word dummy, which means an imitation or substitute for the real thing, as in a ventriloquist's large puppet. In radio frequency practice, it is a kind of "black hole" for incoming radio signals: the energy goes in, but never comes back out again.

What is a dummy antenna? It is really a resistor (or group of resistors) matched to the characteristic impedance of the feed line, and it has a power-dissipation rating at least as great as the transmitter's output power. An important requirement is that it have no inductive component which could make it frequency-sensitive. It should provide a voltage standing wave ratio (VSWR) as close as possible to 1.0.

A dummy antenna can also be a useful tool for testing receivers for internally generated noise. This test can be performed when the receiver is effectively shielded from any external interference that could enter its antenna terminals. These tests are usually carried out in metal-screened enclosures called, appropriately enough, *screen rooms*.

The design of a dummy antenna design will depend on the transmitter's operating frequency and power. For low-power cirizen band or or marine-band radio transmitters, the dummy antenna is typically a small, machined cylinder that includes both a coaxial cable receptacle and resistor. The feed-cable plug is disconnected from the antenna and plugged into the load receptacle. A factory-made unit of this kind could cost up to $50.

At microwave frequencies, a dummy antenna can be a waveguide section that includes graphited sand which acts as the resistor. If transmitter output power is to be determined, the waveguide section will include a *water load* that acts as a calorimeter. Power dissipation can be calculated from the increase in water temperature.

Build your own

One way to learn more about dummy antennas—and at the same time save money—is to make your own. The dummy antenna described here is easy to make from low-cost, readily available parts, and you can save a few dollars over the price of even the lowest cost store-bought unit.

To build this dummy antenna, you will need eight 100-ohm, 3-watt carbon resistors, an SO-239 UHF coaxial panel receptacle, a one-gallon paint can, and some brass strips. The resistors and receptacle can be obtained from mail-order houses or most electronics stores, and the new, clean gallon container can be obtained from a paint store. (They are stocked for custom-mixed paint.)

Figure 1 is a cutaway view of the completed dummy antenna. Note that the resistors are arranged in a series-parallel network formed by soldering them to parallel strips of sheet brass. The strips are ½-inch wide, 20- to 30-gauge sheet brass, obtainable precut in lengths of two feet or more from many building supply and hardware stores. The flat strip form reduces possible effective inductance, and brass is stiffer than copper of comparable thickess. It also has a lower resistance than iron or steel.

If molded carbon-composition units are not available, car-

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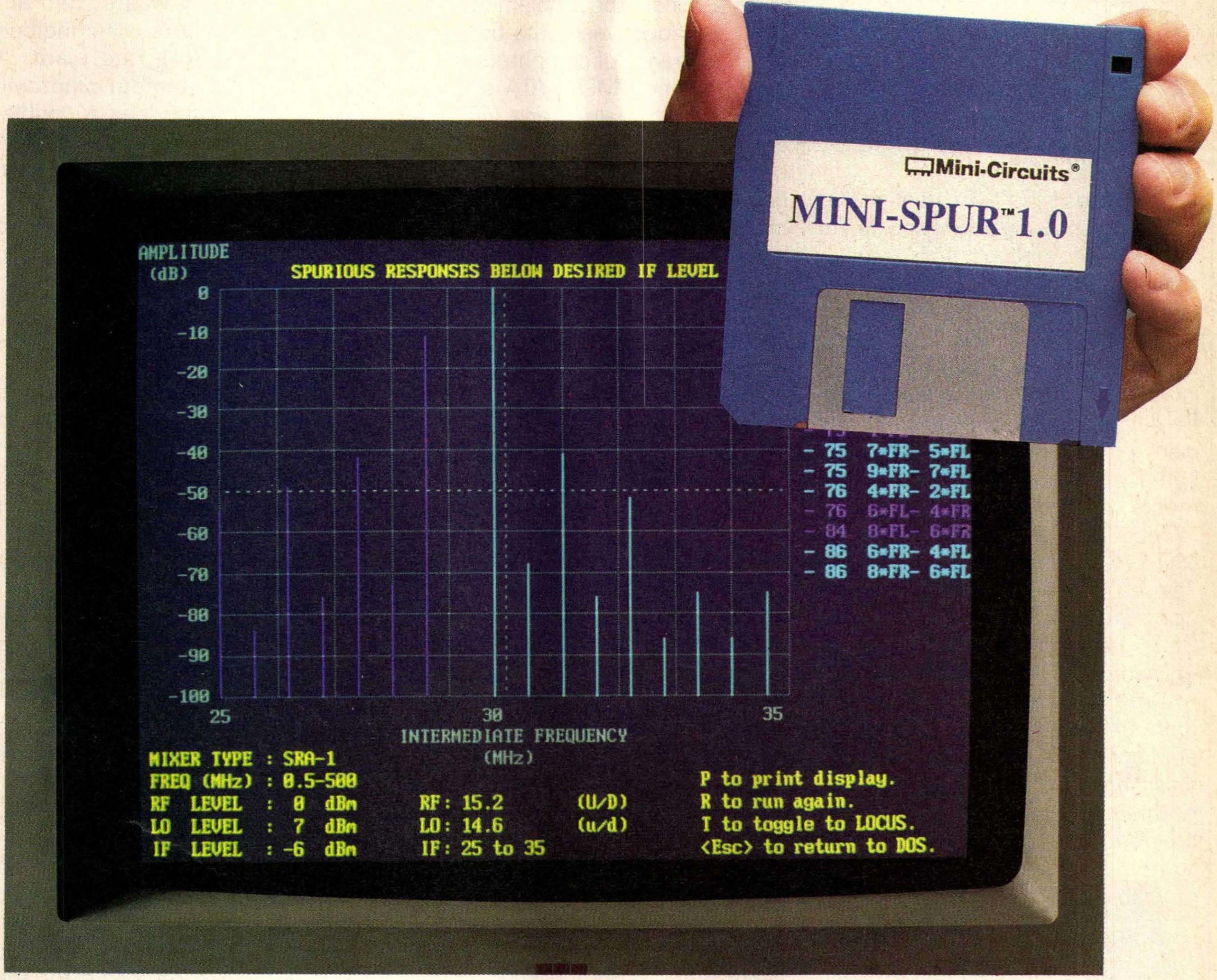

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- 75  7*FR- 5*FL
- 75  9*FR- 7*FL
- 76  4*FR- 2*FL
- 76  6*FL- 4*FR
- 84  8*FL- 6*FR
- 86  6*FR- 4*FL
- 86  8*FR- 6*FL

MIXER TYPE  : SRA-1
FREQ (MHz)  : 0.5-500                               P to print display.
RF  LEVEL   :  0  dBm     RF: 15.2        (U/D)     R to run again.
LO  LEVEL   :  7  dBm     LO: 14.6        (u/d)     T to toggle to LOCUS.
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CIRCLE 182 ON FREE INFORMATION CARD

WHAT'S NEWS

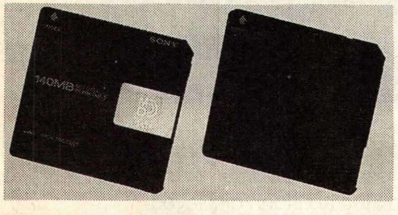
A review of the latest happenings in electronics.

MiniDisc Data Discs

Building on its audio MiniDisc specifications, Sony has announced a set of standards for its MD DATA, a compact data storage medium for personal computers that it hopes will replace magneto-optical floppy disks.

Sony sees MD DATA meeting the computer industry's growing need for more compact, high-density storage. The new MD DATA discs will hold graphic and audio data as well as text. They offer 140-megabytes of memory capacity; this allows the storage of about 2000 frames of still color images on each disc. A data-transfer rate of 150 kilobytes per second allows them to record full-motion video.

There are three different kinds of MD DATA discs, and all can be "played" on a single drive mechanism. Prerecorded MD DATA ("MD ROM") discs contain prepackaged software, while recordable "Rewritable MD" discs are for personal data-storage use. For interactive applications, "Hybrid MD DATA" discs have some sectors that are permanently prerecorded, leaving others for the user's data.



SONY'S 140-MBYTE MD DATA computer discs include the blank disc (left) that could replace today's floppy disk, and the preprogrammed "firmware" version (right). A third disc contain both preprogrammed and blank sectors.

As part of its MD DATA standard, Sony has developed a file system that determines how information is encoded onto the disc. The system provides compatibility between computers that have different microprocessors or different operating systems.

According to Sony, MD DATA discs eliminate the problem of interchanging floppy disk data between different brands of computers. They say that once MD DATA system software is installed, any information written onto MD DATA discs can be retrieved and modified, regardless of differences in the CPU's or operating systems.

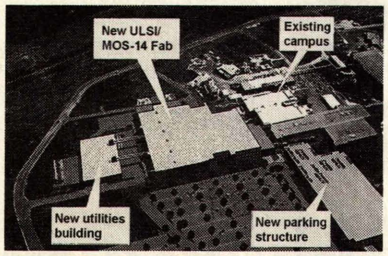
The discs are similar in appearance to, but can easily be distinguished from, audio MiniDiscs. MD DATA discs are encoded to prevent playback and recording on MD audio systems.

Motorola Facility slated for 1995 opening

Motorola has announced its plans to start construction in October on a new combined advanced products R&D laboratory and metal-oxide semiconductor (MOS) manufacturing plant at Austin, Texas.

The facility will produce, among other devices, advanced RISC and CISC microprocessors, and fast static-RAM memory. The 800,000-square-foot facility is expected to cost between $850 million and $1 billion. It will contain 90,000 square feet of Class-One clean-room of which 34,000 square feet will be assigned as a laboratory and 56,000 will be assigned for wafer fabrication.

Motorola has responded to environmental protection imperatives by limiting the amount of waste gas and chemicals released into the atmosphere and ground. For example, a sulfuric acid recycling system will reduce chemical waste, and air-emission scrubbers will condition air exhausted from the plant. A waste-water treatment plant will clean up the water, and a double-walled chemical storage and delivery system will minimize the toxic chemicals stored at the plant.



MOTOROLA'S R&D LAB AND FACTORY, to be built in Austin, Texas, is expected to open in 1995.

The laboratory is expected to open in early 1995, and manufacturing is slated to begin in 1996.

ISCET authorized to administer FCC exams

The Federal Communications Commission (FCC) has authorized the International Society of Certified Electronics Technicians (ISCET) to administer FCC exams for certificates and permits.

Included are First, Second, and Third Class Radiotelegraph Operator's Certificates, the General Radiotelephone Operator License, the Marine Radio Operator Permit, the Restricted Radiotelephone Operator Permit, the Global Maritime Distress and Safety System (GMDSS) Operator's and Maintainer's Licenses, and the Ship Radar Endorsement.

Out of 60 entities that applied to the FCC to administer the examinations, only nine were selected. Those nine, including ISCET, will receive the question pools for the General Radiotelephone Operator's License and Marine Radio Operator Permit exams by the end of July, 1993. Other elements will be available at a later date, due to an insufficient quantity of available questions for the pool.

ISCET will to have examinations prepared and its test administrators recertified for the FCC exams before the end of August. Information about ISCET and both FCC and Certified Electronics Technicians (CET) exams is available from ISCET, 2708 West Berry, Fort Worth, TX 76109; Phone 817-921-9061, or fax 817-921-3741. Ω

VICA Skill Olympics winners announced

The winners of the 29th annual Vocational Industrial Clubs of America (VICA) United States Skill Olympics were announced this summer. The contests were held at the VICA National Leadership Conference in Louisville, Kentucky. More than 3600 vocational students competed in 53 different trade, technical, and leadership fields.

Competitors worked against the clock and each other to prove their job skills for such occupations as electronics technician, technical draftsperson, machinist, paramedical, and cooking and baking. In the leadership-skills contests, students competed in unrehearsed public speaking and leadership in meetings that followed parliamentary procedure.

In the electronic products servicing contest, the secondary division first-, second- and third-place winners, were Emil Ureel (Port Huron, MI), Robert Barnes (Lincoln, ND), and Bryan Glotzbach (Scottsville, NY), in that order. In the post-secondary division, first-, second-, and third-place honors went to Martin Vigesaa (Fargo, MN), Erwin Biermans (Cape Coral, FL), and Bryan Greene (Florence, KY).

Section I of the electronic products servicing contest was held at six individual test stations. The participants were asked to service modern TVs, VCRs and radios. Section II tested the students' workmanship in soldering as each assembled an electronic kit. Section III was a written exam that tested the participants' understanding of safety procedures, basic electronic theory, and standard servicing practice.

VICA is the national organization for students being trained in technical and health occupations.

The contests, planned by committees made up of representatives of labor and management, are intended to test those skills needed for success in each field. In the electronic products servicing contest, committee members included representatives from the Electronic Industries Association and several electronics and test equipment manufacturers. Ω

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Digital Readout Backlit 4-digit display with big numerals (17mm, 5/8").	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Analog Bar Graph Simulates an analog meter to indicate trends and changes.	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓
Probe Hold™ Store your last stable reading for later; allows safer meter operation because you can keep your eyes on your work.	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓	✓
Peak Hold™ Measure and store peaks as short as 1ms. Detect transients, measure inrush currents, and determine crest factors.	✓	✓	✓	✓		✓					✓	✓	✓	✓
Auto Min Max™ with Averaging Record the minimum, the maximum and the average reading, *unattended.* Fully autoranging for maximum resolution.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Auto Rel™ Relative Mode Read the difference between the present and previously stored values. Fully autoranging for maximum resolution.	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Intermittent Detector Locate intermittents, broken wires, loose connections quickly and easily. Once you've used Wavetek's exclusive Fault Finder™, you'll never want to be without it.	✓	✓	✓	✓	✓	✓					✓	✓	✓	✓

480.7
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V
MIN MAX
10A
100mA
COM
V·Ω
OFF
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VIDEO NEWS

What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• **"Flat Vision" TV.** A unique display device that combines some of the principles of the cathode ray tube with the addressing system of the liquid-crystal display is now in production in Japan. Its developer, Matsushita Electric, maker of Panasonic TV sets, forecasts that "Flat Vision" will take over more than 10% of the world's electronic-display market by the year 2000.

Flat Vision, described as a "beam matrix" tube, has been under development by Matsushita for about 20 years and was demonstrated in early prototype form in 1985. It produces a 14-inch color picture and its first version is about 3.9 inches deep. It is being offered in Japan equipped with a TV tuner (at the forbidding price of almost $2700). However, Matsushita says that its Flat Vision tube can be mass produced more cheaply than a CRT. By the time the product is exported, around the end of next year, it could be competitively priced.

The Flat Vision tube is said to be the equivalent of about 10,000 tiny individual picture tubes, all in the same evacuated glass envelope. In place of the electron gun in CRT's, it has 44 horizontal "line cathodes," which run the width of the tube. Mounted vertically are 222 control electrodes, producing 9768 junctions where the cathode and control electrodes cross. Each junction, or matrix, controls its own screen area with 20 sets of red, green, and blue phosphor dots, 10 sets vertically by two horizontally.

Although the display works as a conventional picture tube—electron beams activate phosphor dots, making them glow—it is addressed by a series of flat electrodes (within the glass sandwich). Matsushita expects to build the tube for displays as large as 25 inches, and possibly to 40 inches. It expects Flat Vision tubes to become common for computers, multimedia devices, and other applications that will benefit from slim dimensions and high picture quality.

• **Video MiniDisc?** Sony's tiny MiniDisc digital audio recording system is expanding into data storage. The company announced standards for an "MD Data" system that could be used in personal computers or portable digital-data products. Sony plans to try to standardize MD Data as a replacement for the floppy disc. Among its claimed advantages are low cost, higher recording density (actually double that of a CD-ROM), small size, portability, low power consumption, and the ability to store graphics, still pictures, and video.

MD Data has the ability to hold 2000 frames of still color pictures or 15 minutes of compressed full-motion video with digital sound. That last attribute has led industry observers to question whether—or when—the MiniDisc would be adapted as a video-recording medium. Its small size and light weight would make it an obvious candidate for a camcorder medium. However, Sony engineers caution that 15 minutes of video simply isn't enough, and expanded playing and recording time for MiniDisc is still in the future.

In 1992, when the audio MD was introduced, Sony President Norio Ohga said it had a future as a video-recording medium, with the advantage of quick random-access properties—a decided improvement over tape. However, Sony executives told attendees at a recent technical seminar that long-playing, 2½-inch video MD is perhaps five years off. Sony presumably will await the commercial introduction of a suitable blue laser for recording on an optical disc with a much smaller spot size than current infrared models. A continuous-wave blue laser with a wavelength of 460 to 500 nanometers (compared with 780 nm for infrared lasers) could lead to many new applications of optical discs by increasing recording density by a factor of 2.5. Sony has already succeeded in achieving stable emission of a blue-green semiconductor laser at room temperature, considered a step toward the blue laser.

• **Cable interface.** The cable-TV and consumer-electronics industries have agreed on a series of steps to make cable systems more compatible with such home equipment as TV sets and VCR's. They have submitted their recommendations to the FCC, as required by the Cable TV Act of 1992. In the near term, the agreement provides for signal scrambling only as a last resort—where other measures aren't effective.

In the longer term, the two factions agreed to work together to develop a "decoder interface" for the back of TV's and VCR's to permit "signals to exit and enter the TV or VCR for external descrambling or decryption," eliminating the need for set-top boxes. That interface would work with either analog or digital signals, anticipating digital cable systems. It would permit access to all channels without the need for a converter. This would reduce duplication of circuits between the TV and cable system, thus increasing video and audio quality by eliminating redundant processing. It would also reduce energy consumption.

Receiver manufacturers agreed to improve the front-end design of their sets to facilitate both broadcast and cable reception, and to eliminate direct pickup problems when broadcast and cable programs are on the same channel. To compensate for the increased cost of the sets, the FCC was asked to require lower cable subscriber rates. Ω

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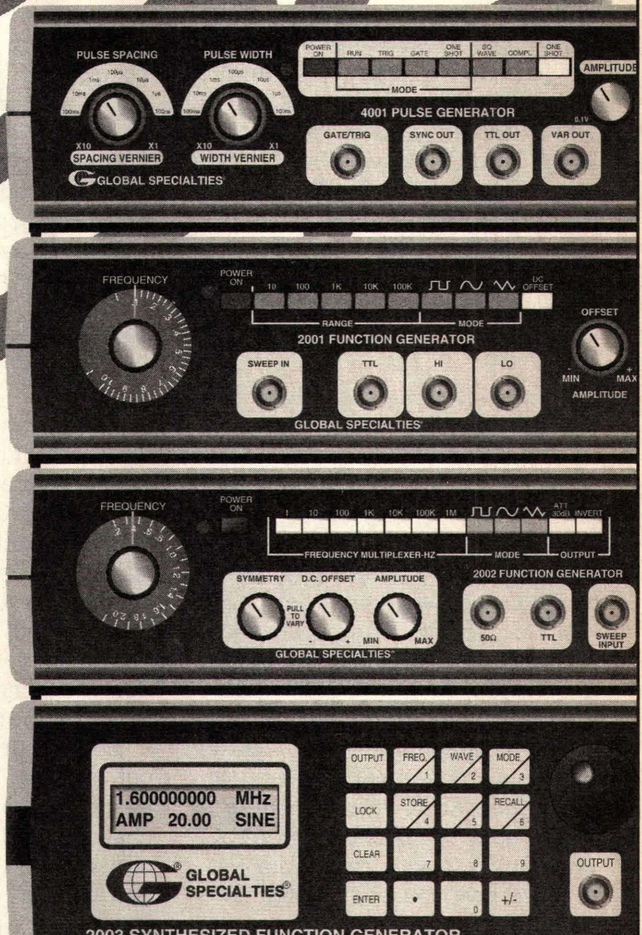
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Q & A

Write to Q & A, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

FUSSY BBS

I finally gave in to all the advertisements for Prodigy and bought a new 9600-baud modem. After several weeks of effort I'm still unable to use their service—I always get an error message when I call. Since it seems to take about a half hour to get someone on the phone, and another half hour to find out that his suggestions don't work, I'm just about at my wits end. I know *Electronics Now* is not a computer magazine, but at this point I don't know what to do. Any suggestions?—R. Bishef, Keystone, SD

And all this time I thought that only happened to me! I also had teething problems with Prodigy and perhaps what I found out can help you.

Prodigy's software is one of the pickiest communications programs I have ever seen. Sometimes it won't even work with modems that have no trouble connecting to any other dial-up service in the universe. Although I don't pretend to know all there is to know about Prodigy, I've managed to make some empirical observations that might be helpful to you, assuming that your modem is working correctly.

The most important thing to realize is that Prodigy will not tolerate an IRQ conflict. Even if your modem is smart enough to share interrupts with another piece of hardware, Prodigy will give you an error (either a 25 or 26). The DIAGNOSE program supplied with Prodigy will refuse to even test a modem if there's an interrupt conflict.

There's no understandable relationship between the modem baud rate reported by DIAGNOSE and the actual capability of your modem. When I run it in my computer, it reports back 2400 baud even though I connect to Prodigy at 9600.

The DIAGNOSE program responds strangely to interrupts. The "Check Ports" option will correctly locate a modem and identify its assigned interrupt regardless of the interrupt line you use. The "Check Modem" option, however, will refuse to find, much less test, a modem that uses a non-standard port address/interrupt combination. And if your modem is configured for either IRQ2 or IRQ5, the "Check Modem" option won't work regardless of the COM port you're using.

I'm mentioning these anomalies so you'll understand that your modem might work perfectly well with the Prodigy software and still fail to be recognized by their diagnostic software. Or vice versa, for that matter. That's the case with me.

Prodigy's software wants to deal with a modem that has absolutely no special features at all. This includes such things as MNP error correction and data compression. As a result, you have to add a modem initialization string to the end of the CONFIG.SM file in your Prodigy directory. You can use an ASCII text editor or, more awkwardly, the MODEMUTL program supplied with Prodigy.

I'm sure you've heard this before from the technical support people at Prodigy, but you'll have to go through your modem manual and put together a string that disables everything your modem can do except respond to commands. If this doesn't take care of the problem and you still want to use Prodigy, you'll have to get another modem. It might sound silly, but as long as you understand that the problem is with Prodigy and not your modem, you can at least make an informed decision about what to do.

HEARING AID

I've been repairing monitors for years, and occasionally I get one that gives off a high-frequency squeal (around 15 kHz) from the horizontal oscillator. My problem is that I can't hear the squeal, although other technicians 25 feet away can. Is there a simple circuit I can build that will detect this sound and indicate its presence on something I can see?—G. Swindell, Deptford, NJ

What you need is a frequency detector, which consists of two basic circuits. The first section has to capture the sound from the environment, and that means a microphone and maybe an amplifier is needed. The second section has to react only to the presence of only the frequency you're interested in—namely 15 kHz.

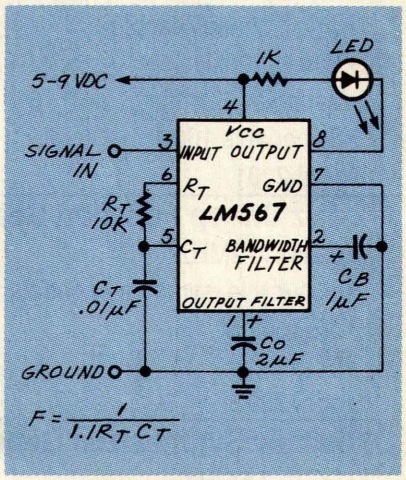

FIG. 1—THIS CIRCUIT will detect the presence of a 15-kHz audio signal and light the LED when it does so.

Most microphones and amplifiers available today have bandwidths that go way beyond 15 kHz, so the first half of your circuit is easy. You can either build a simple amplifier circuit or just use the output of any audio tape recorder that has a built-in microphone.

The second half of the system, the one that is frequency-sensitive, is much more interesting. Although there are several ways you could build something like this, the easiest way to do it is to base the circuit around an LM567 tone-decoder

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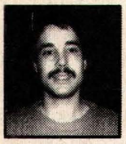

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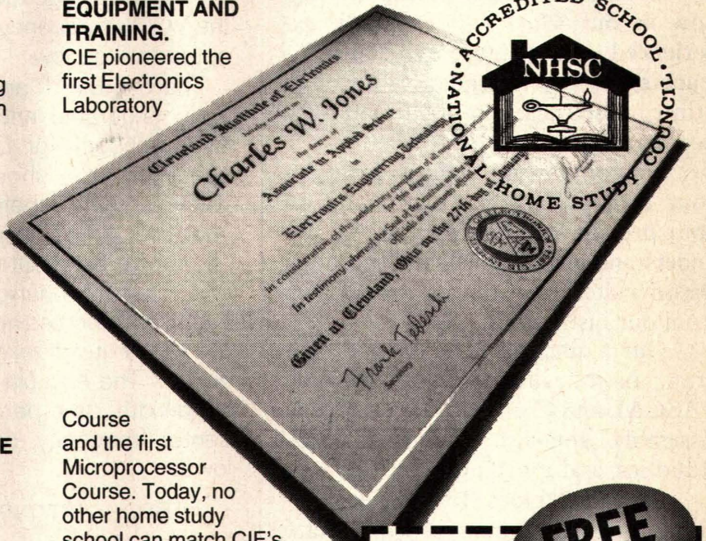
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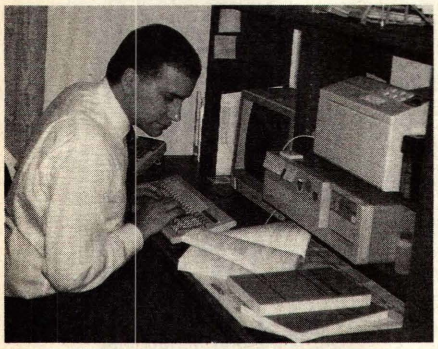

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IC—it's specially made for the job. It started its life as the heart of most telephone DTMF decoders, but that job has been passed on to more specialized ICs.

The LM567 is an 8-pin DIP IC that can be made into a tone detector with the addition of only four components as shown in Fig. 1. The values of the timing components R_T and C_T have been chosen to give the LM567 a center bandwidth of about 15 kHz.

The chip has an on-board voltage controlled oscillator (VCO) whose output frequency is set by R_T and C_T. Two phase detectors within the IC compare the input frequency to the center frequency of the VCO. When the input frequency is within the capture range (centered around the VCO's frequency), the LM567's output will go low.

The bandwidth and output delay are configurable, and are set by the values chosen for C_B and C_O, respectively. You should experiment with the LM567 before settling on your final circuit design. In general, C_O should be about twice the value of C_B, and the narrower the bandwidth (with increasing values of C_B), the longer it will take the output to go low. The formula for calculating bandwidth, as a percentage of the center frequency, or f_C, is as follows:

$$BW = 1070\sqrt{V_{IN}/f_C C_B}$$

Even though the LM567 is a fairly simple chip to use, it's a good idea to have a data sheet in front of you while you're designing the circuit since the math shown on the sheet can speed up the design work.

TEMPERAMENTAL HARD DRIVE

The hard drive in my computer seems to be temperature sensitive. When the temperature drops below 60° or so, I get "boot disk failure" messages. If I leave it turned on for a while, it will eventually work. What's causing this problem, is it dangerous, and what can I do about it?—J. Lewin, Ridgefield, CT

Even though all hard drives have specified temperature ranges, temperature sensitivity is more likely to be a problem with older MFM drives than with the newer IDE drives.

A tremendous amount of accuracy is needed to place the head over the center of each track. Because the spinning platters change dimensions slightly with temperature, the platters in a cold drive might contract to the point where the head isn't positioned accurately over the track. Cold drives might not be able to come up to full speed either (about 3300 RPM), and the internal tachometer won't allow a "drive ready" signal to be sent back to the controller when you turn on the computer.

As far as it being dangerous, I presume you're talking about your data, or the loss of it. If you write to a drive before it reaches operating temperature, you won't write to the exact center of each track. That can make the recording unreliable because, once the drive has warmed up, the signal from the center of the track will be weaker (since it was written off-center). The possible crosstalk between adjacent tracks can also cause problems in reading data. You didn't mention it, but I'm willing to bet that when you finally do get the drive working, you get lots of "Sector Not Found" and "Data CRC" errors as well.

The best thing to do with this drive is transfer everything onto a bunch of floppies and reformat the drive from as basic a level as you can. This is a low-level format for MFM and RLL drives, and a complete DOS format for all drives. And don't do it until the drive has been running for a half hour so it's warmed up. You don't want to mess around with data!

AIRLINE PHONES

I am interested in using my scanner to monitor telephone calls made from airplanes. Where should I look?—R. Turner, Albany, NY.

Ground-station uplinks for most airplane-based telephone services are in the 849 and 851 MHz band. Downlinks from the airplanes are in the band from 894 to 896 MHz. Channels are spaced 6 kHz apart. Various modulation techniques are used, including FM, SSB, and on some systems, digital. Digitally modulated signals can't be received by a conventional scanner. Ω

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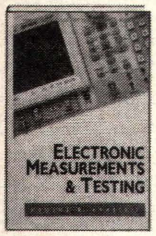
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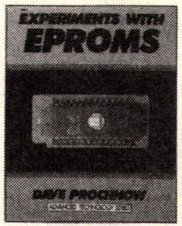
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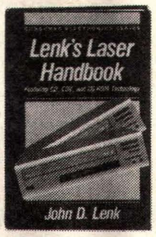
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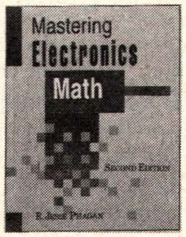
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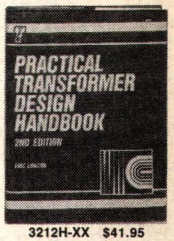
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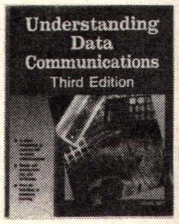
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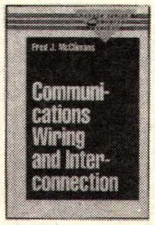
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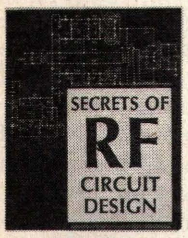
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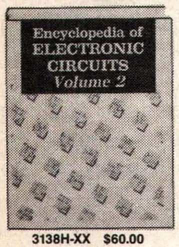
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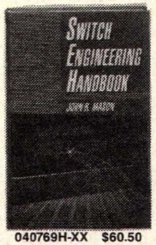
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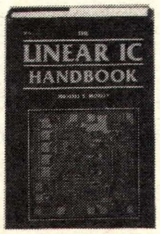
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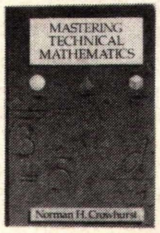
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LETTERS

Write to Letters, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

FOREIGN EXCHANGE

I have a simple, but perhaps expensive solution to the problem posed in *Q&A* (**Electronics Now**, August 1993) by a French-speaking reader who would like to enter foreign-letter accents with his word processor

A program called "French Assistant," available from several sources (including MicroTac Software of San Diego, CA), transates English text to French and vice-versa. Its ability to translate accurately is limited by the user's knowledge of the French. However, the program includes a utility called FRENTOOL.EXE, an excellent dictionary and grammar tutor that can also produce accent marks in word processed text. It can be loaded as a TSR and called up with a user-selectable hot key.

I write a lot of French, and this software has proved to be satisfactory. I load the TSR as part of the BAT file I use to call up the word processor and printer configuration programs. FRENTOOL can be loaded into a RAM drive for higher speed, and it can be unloaded with the command FRENTOOL /U.

EMERSON M. HOYT
Beaverton, OR

SO MUCH BASS ...

The article "How Do They Get So Much Bass Out Of Such Little Boxes?" by Dale Blackwell that appeared on page 67 in the May 1993 issue of **Electronics Now** compelled me make a short response: "They don't."

Any article about bass cabinets that does not recognize and refer to the work in that field by Thiele or Small should be viewed with suspicion; its like discussing relativity without mentioning Einstein.

Mr. Blackwell said that reducing the size of the cabinet raises its cutoff frequency. He also said that a larger speaker makes the cabinet "look" smaller. That is not correct. Two speakers that have identical Thiele/Small parameters and different diameters will have the same cutoff frequency in any given enclosure. Cutoff frequency is a function of enclosure compliance, which is a function of the volume of the enclosure.

The "inside surface area" is totally irrelevant. Two enclosures with equal volume and different surface areas will have the same cutoff frequency. Many people have assumed that the port is tuned to the free-air resonance of the loudspeaker in a base-reflex cabinet. That is true only in certain well-defined circumstances.

I have speakers with a free air resonance of 84 Hz, in an enclosure with a volume of approximately 1.4-cubic feet, and they have a cutoff frequency of about 50 Hz. The enclosure is tuned to 58 Hz.

Mr. Blackwell asserts that the port must have at least half the area of the speaker to be an effective power radiator. Acoustic engineers have long known that the efficiency of the system is a function of its cutoff frequency and the enclosure volume. The output of the port is *not* related to the cross-sectional area of the port.Consider the following equation:

$\eta = k_\eta f_3 V_b$,

where η is basic system efficiency

k_η is efficiency content which depends on the driver's electromagnetic damping

f_3 is the cutoff frequency

V_b is enclosure volume

Next, examine the equation for a ported cabinet (or a Hemholtz resonator):

$f_b = C/2\pi[S_v/(L_{ve} V_b]^{1/2}$,

where F_b is enclosure resonance

C is enclosure sound velocity

$S = s_v$ is vent cross-sectional area

L_{ve} is effective vent length

V_b is internal enclosure volume

There are many possible combinations of vent length and vent area that will yield the same enclosure frequency. Blackwell shows no evidence of a knowledge of sealed or ported systems.

The ported enclosure is analogous to a fourth-order, high-pass filter with a 24 dB/octave rolloff, not 18 dB/octave. The sealed cabinet is analogous to a second-order filter. Those schooled in filter theory will recognize that any of the classical filter arrangements can be obtained by changing the appropriate mathematical coefficients.

It turns out that the efficiency of a ported system is about 4.5 dB higher than that of a comparable sealed system. Why are so many bookshelf systems sealed? The answer is that below the cutoff frequency, ported systems are more sensitive to damage, for a variety of reasons. This becomes a more serious problem in small bookshelf systems whose cutoff frequency is higher. This is of concern to equipment manufacturers.

Any survey will show that the vast majority of professional monitoring systems are ported cabinets.

Now back to the original question. Changing the transfer function so that a bass boost is realized results only in in the illusion of "so much bass."

GREG FREITAG
Potsdam, NY

The author, Dale Blackwell, responds:

In responding to Mr. Freitag's letter, I first want to emphasize that when considering speaker systems, the only characteristic that counts is what we can hear. Other measurements, however startling or unique, are meaningless unless they are related to what is audible.

Our ears respond only to pressure, not to velocity. Therefore, only measurements of sound pressure level *are meaningful. Sound-pressure level is measured in dynes/square centimeter.*

Second, a lot of measurements that can be made on speaker sys-

tems including impedance, efficiency, response (sound pressure level vs. frequency), directivity, and power-handling capability. Those measurements are useful, as are computer simulations, in the understanding and quantifying evets within a speaker system.

In the specific case of low frequencies, the range discussed in my article, impedance curves will help one to gain insight about those events. However, they do not replace the frequency response curve, which plots the sound pressure level vs. frequency over the audio range.

Impedance curves only show the motion of the speaker over the frequency range. Sound-pressure level measurements permit correlations to be made with impedance measurements. These allow the sound-pressure level vs. frequency response to be estimated.

In response to Mr. Freitag's criticism of my omission of any mention of Thiele and Small, I'd like to point out that my reference to the design of speakers and enclosures in accordance with network theory was an indirect reference to those authors. I did not want to complicate an already complex subject.

The article discussed what can be done with the speaker, cavity, and a port. No frequency compensation of the input signal was considered to offset losses in sound pressure level due to limitations in the speaker system.

The enclosure volume (cavity) sets the box compliance, and the resonance for a closed-box system is that reactance (cavity) tuned with the reactance of the mass of the moving part of the speaker (cone, voice coil, coil form) and the air-load mass on the cone.

If the speaker diameter is increased, the volume of the cavity looks smaller to the speaker. The larger cone area (and, as a result, less cabinet area for the same cabinet) moving a larger air volume is now compared to a smaller cavity volume (cavity volume minus the cone air volume). I simplified this relationship to an apparent reduction of surface area of the cavity.

If a port is now added in the cavity, the reactance of the mass of air in the port (inertance) with the cavity compliance can be tuned at any frequency consistent with reasonable enclosure dimensions.

To lower the frequency of resonance with the same cavity volume, however, the port area must be reduced, or the length must be increased. This now raises the question of what sound-pressure level can be produced at these low frequencies, with a small diameter opening.

As the area is reduced, the amplitude must increase for a constant sound-pressure level. The result is that a 16-inch diameter piston (the approximate size of a woofer with an 18 inch diameter) must travel only about 0.05 inch at 100 Hz for 1 watt of acoustic output.

By contrast, for a 4-inch diameter piston, that distance must increase to about a 0.8-inch travel. With small ports of 2 inches in diameter or less, it should be obvious that the air travel will be prohibitively large at, say, 50 Hz, where even the 16-inch piston must travel 0.2-inch. The 2-inch diameter piston must travel over 3 inches! There is excessive loss due to the viscosity of the air.

My analysis of what occurs in the speaker system described by Mr. Freitag is simply this: If you look at an impedance curve for his system, you will see a double "bump" — referred to in some literature as f_h— for the high-frequency impedance bump, f_L for the low-frequency impedance bump, and f_b for the cavity resonance and dip between the two bumps.

The cavity is a resonant chamber that is canceling the speaker's resonance. That's why the dip exists and produces two bumps. The cavity resonance produces large air vibration in the port, the source of radiating sound, if there is enough area to produce a reasonable sound-pressure level.

Notice that at the dip frequency, the speaker cone is not moving, an effect that can be verified visually. That's why the impedance dips to a minimum. If the port tube is too

continued on page 88

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EQUIPMENT REPORTS

Wavetek Model 2010 Digital Multimeter

When the Instrumentation Products Division of Beckman Industrial was purchased by Wavetek Corporation (Instruments Division, 9045 Balboa Avenue, San Diego, CA 92123) we were somewhat concerned. We had long been fans of Beckman's professional DMM's and we were worried that the new corporate arrangement would affect product quality. After having the opportunity to examine Wavetek's newest multimeter, the model 2010, our worries have been alleviated.

The model 2010 adds a 2-MHz frequency and a 2000-microfarad capacitance meter to the standard DMM capabilities of measuring resistance and AC and DC voltage and current. A collection of special features—including the ability to capture and display minimum and maximum readings—make it ideally suited in professional applications.

The multimeter is housed in a black high-impact thermoplastic case that measures about $7\frac{1}{2} \times 3\frac{1}{2} \times 1\frac{3}{10}$ inches and weighs 20 ounces. The front of the case contains a large 4½-digit, 19,999-count LCD, five push-button feature selectors, a 10-position rotary function selector, and four input jacks.

The LCD incorporates an analog bar graph in addition to the ⅝-inch digit display. The bargraph, which consists of a moving pointer on a scale, updates twenty times per second.

Below the LCD are five buttons that serve to access many of the features of the 2010 and that permit the user to adjust the meter's measurement ranges manually. Left and right cursor buttons call up a menu when first pushed, and they move a cursor either left or right on subsequent pushes. When the cursor is under one of the choices (HLD for probe-hold, for example) pressing the select key (indicated by a check mark) turns the feature on.

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New DMM offers Fault Finder to detect shorts, opens, and intermittents.

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The probe-hold feature allows the DMM user to take a measurement and then remove the probes form the circuit while the measured value remains displayed. It's convenient when making measurements in awkward positions.

An auto-relative mode permits measurements to be made with respect to a preset reference value. For example, if the ideal output for a power supply is input to serve as the measurement baseline, other power supplies could be tested quickly to see whether they were within acceptable tolerances.

An auto min/max mode makes it possible to record the minimum, maximum, and running average of input signals. It is ideal for monitoring voltage swings when the meter is left unattended.

A peak-hold feature can capture and hold voltage and current measurements as short as one millisecond. It is useful for monitoring power-line transients or inrush current.

When the Fault-Finder feature is selected, the model 2010 emits a tone whose pitch changes with the input signal. For example, if the input voltage, current, resistance, or capacitance increases, the tone will increase in frequency.

Ranges and accuracy

The model 2010 measures DC and AC voltage over five ranges (100 millivolts to 1000 volts) with resolutions that vary from 0.01 millivolts to 100 millivolts. Over all ranges, the meter's basic accuracy for DC voltage measurements is 0.25% of the reading, +2 digits. For AC voltage measurements, the rated accuracy is 2% of the reading +8 digits.

AC and DC current can be measured with the 2010 over five ranges (1000 microamperes to 20 amperes) with resolutions from 0.01 microamperes to 10 milliamperes. Worst case accuracy is 1% of reading +2 digits for DC measurements, and 1.7% + 8 digits for AC measurements.

Resistance measurements are made over seven ranges from 100 ohms to 20 megohms. Corresponding measurement resolution varies from 0.01 ohms to 10 kilohms. Worst-case accuracy is 1.2% of reading +4 digits.

Capacitance can be measured over 6 ranges (0.2 microfarads to 2000 microfarads) with resolutions that vary from 100 picofarads to 1 microfarad. Worst-case accuracy is 3% of reading +8 digits.

Frequency can be measured over three ranges (20 kHz to 2 MHz) with resolutions from 1 Hz to 100 Hz. Rated accuracy is 0.2% of reading + 2 digits. The duty cycle of inputs from 40 Hz to 100 kHz can also be measured. Worst-case accuracy is 5% of reading + 1 digit,

The model 2010 comes equipped with a protective holster that features both a tilt bale and a hanging strap. It is priced competitively at $239. Ω

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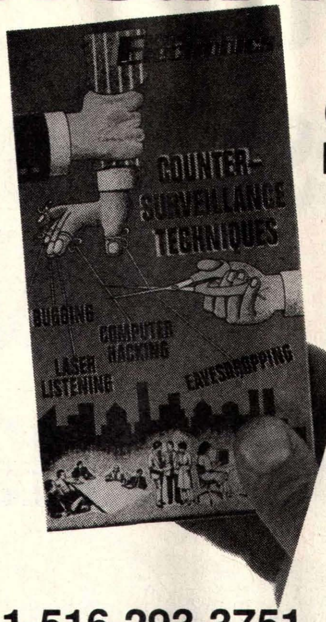

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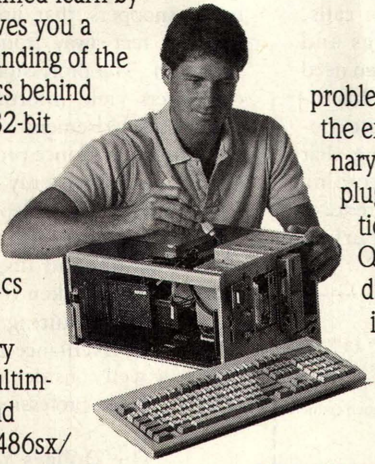

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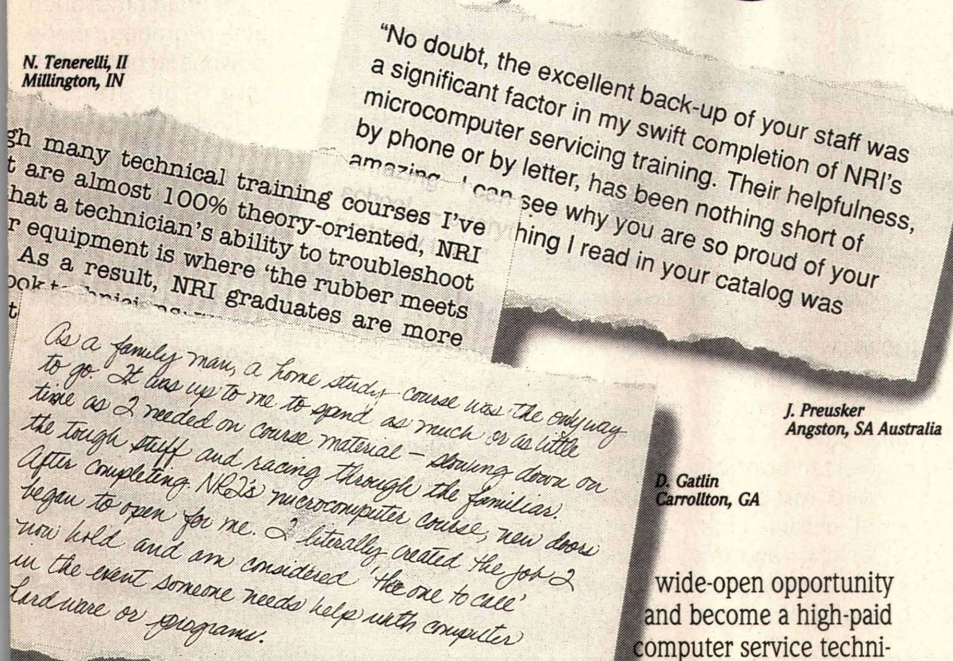

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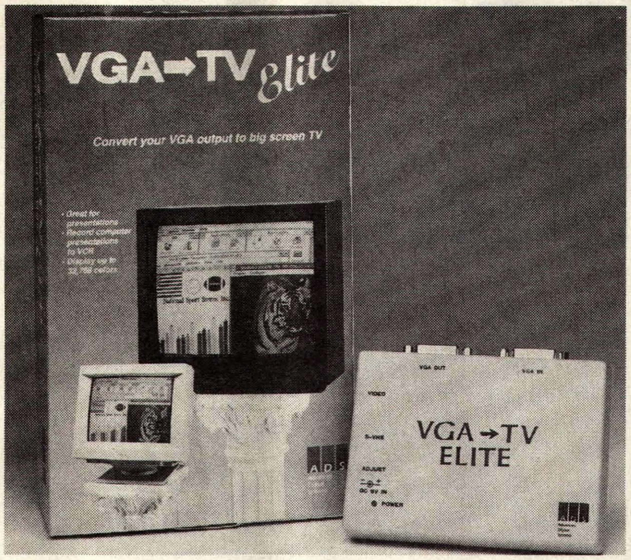

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CIRCLE 16 ON FREE INFORMATION CARD

Threshold voltage and maximum gain are taken automatically, so the alignment of cursors and markers need not be done manually. The instruments include "built-in" HP Instrument BASIC for complex analysis or sequential test automation. A detachable keyboard permits the testing to be performed remotely inside clean rooms. Programs and test results can be exchanged over the bus or through the internal MS-DOS-compatible floppy disk drive.

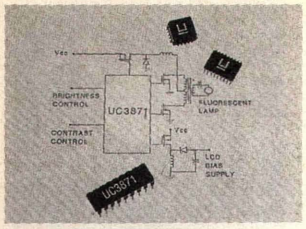
Custom measurement modes simplify incoming inspection, failure analysis, and reliability testing. The stress mode can analyze failure mechanisms such as metal migration, oxide breakdown, and hot-carrier trapping. The standby mode allows a device to be biased continually while multiple tests are performed. A knob-sweep mode gives the interactive flexibility of a curve tracer for the analysis of semiconductor breakdown.

The *HP 4155A* semiconductor parameter analyzer is priced at $29,000 and the *HP 4156A* is priced at $34,450.

Hewlett-Packard Company
Direct Marketing
Organization
P. O. Box 58059
MS51L-SJ
Santa Clara, CA 95051
Phone: 1-800-452-4844.

FLUORESCENT LAMP DRIVER. This integrated circuit from *Unitrode* will drive the cold-cathode fluorescent lamp that backlights a liquid-crystal display (LCD). The *UC3871* includes circuits for background brightness control, LCD-contrast control, and fault detection.

Fully synchronous operation of the IC eliminates distracting lines on the display. Zero-voltage switching and sinusoidal output waveforms are said to increase the battery life of



CIRCLE 17 ON FREE INFORMATION CARD

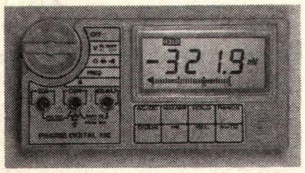
the host equipment while minimizing EMI generation.

An open-lamp detect circuit senses the lamp-current feedback at the error amplifier input and shuts down the output if insufficient current is present. The *UC3871* can be powered from a 4.5- to 20-volt supply.

The *UC3871* fluorescent lamp driver sells for $3.05 each in thousand-piece quantities.

Unitrode Integrated Circuits Corporation
7 Continental Boulevard
Merrimack, NH 03054
Phone: 603-424-2410
Fax: 603-424-3460

RS-232-CONTROLLED DIGITAL MULTIMETER. *Prairie Digital's* digital multimeter measures true rms AC voltage and current, DC voltage and current, resistance, and frequency. The *Model 150-02* also does continuity and diode testing, and can be remotely controlled through its RS-232C serial port. Its internal microprocessor permits front-panel control of baud rate.



CIRCLE 18 ON FREE INFORMATION CARD

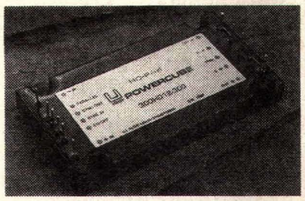
The DMM will work with any computer that has an RS-232C port, but the included software and cable are IBM PC- and DOS-compatible. The data-logging software will transfer measurements to the computer's screen, printer, or a disk drive. The recording interval is programmable, and readings can be time and date stamped.

The software also includes a program that demonstrates how the *150-02* can be controlled and read by the host computer. Source code is included for both programs.

The *150-02* remote-controlled DMM is priced at $179.

Prairie Digital, Inc.
846 17th Street
Industrial Park
Prairie du Sac, WI 53578
Phone: 608-643-8599
Fax: 608-643-6754.

DC/DC CONVERTERS. *Powercube* has introduced a new series of 300-volt DC input DC/DC converters. The *HD-Pak* series is intended for powering computers, test equipment, and machine-tools. All models operate at a fixed switching frequency of 350 kHz.



CIRCLE 19 ON FREE INFORMATION CARD

Powercube claims that its integrated magnetic packaging permits it to offer converters that have 50% more power density than competing products. The converters are in industry standard (4.6 × 2.4 × 0.5-inch) packages, and they are said to have efficiencies as high as 90%.

Standard models provide 2.6-, 3.3-, or 5- volt DC outputs at 40 amperes. Turbo models offer 60 amperes with the same out-

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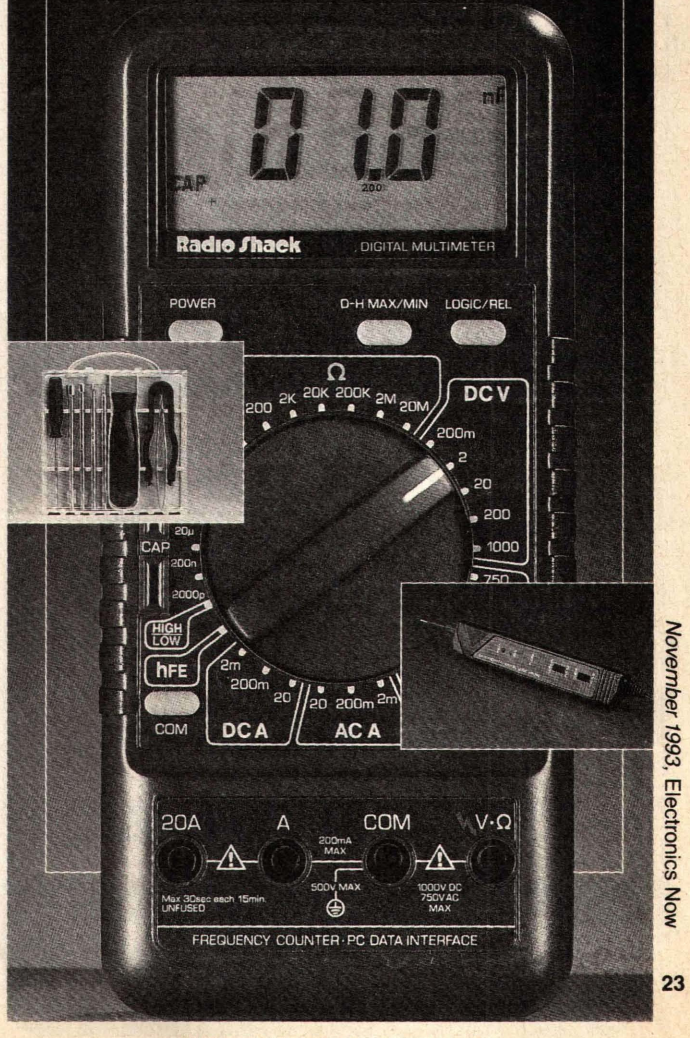
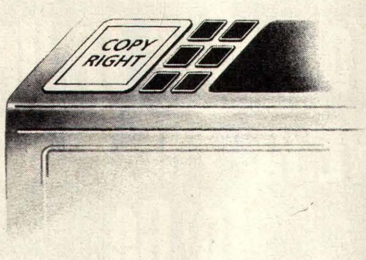


CIRCLE 78 ON FREE INFORMATION CARD



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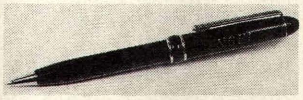
Powercube Corporation
8 Suburban Park Drive
Billerica, MA 01821
Phone: 508-667-9500
Fax: 508-667-6280.

AMATEUR RADIO PEN. How about a special pen for writing in your ham shack with your call letters engraved on it? You can use it to fill out QSL's and logs. The *KTRB* from *Kilo-Tec* is a roller-ball pen that can be engraved with your call letters or your company logo.



CIRCLE 20 ON FREE INFORMATION CARD

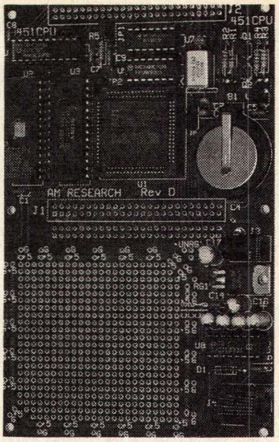
The pen has a high-gloss black finish with gold trim. Up to 25 letters will be engraved on one line as part of the purchase price.

The *KTRB* pen is priced at $19.95 plus $4 shipping and handling.

Kilo-Tec
P. O. Box 10
Oak View, CA 93022
Phone: 805-646-9645.

EMBEDDED MICROCONTROLLERS. Two new controller boards include CMOS versions of the Intel 8051 microcontroller. The *amr451LC* and *amr552LC* are 4 × 6-inch microcontroller boardss that contain an RS-232C port and +5-volt regulation.

Standard features include sockets for up to 32 kilobits of RAM and ROM, as many as 56 I/Os, dual pulse-width modulators, and eight-channel 8- or 10-bit resolution analog-to-digital converters. The boards can have five timer/counters with expanded compare functions. They have space for prototyping circuits and can be expanded by an additional 256 bits of I/O. A lithium battery provides RAM backup.



CIRCLE 21 ON FREE INFORMATION CARD

Systems including the microcontroller boards contain development software tools including FORTH high-level interpretive language. Other features include a full-screen editor, an in-line assembler, a source-level single-step debugger, a decompiler, a disassembler, a power source, cables, and a 300-page manual.

Microcontroller boards are priced a $99; systems cost $199.

AM Research
4600 Hidden Oaks Lane
Loomis, CA 95650
Phone: 800-949-8051
(technical information:
916-652-7472).

BENCH-STYLE DIGITAL MULTIMETER. *B+K Precision* is offering a new benchtop digital multimeter that also measures capacitance and counts frequency. The Model 2835 has a basic DC-voltage accuracy of 0.5%. It can be operated from the AC line or battery power, with battery life rated at up to 1800 hours.

The DMM's functions include AC/DC voltage and current measurement, resistance measurement, diode check, and continuity check. Frequencies up to 1 MHz can be measured with up to 1-Hz resolution, and capacitance can be measured up to 40 microfarads with one picofarad resolution.

CIRCLE 22 ON FREE INFORMATION CARD

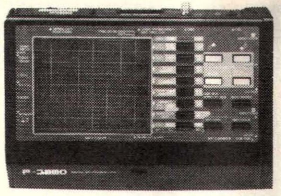
Other features include autoranging and a high-contrast, backlit liquid-crystal display with a 42-segment bargraph for analog indications. The *Model 2835* is in a case that measures 2.9 × 8.6 × 7.7 inches with storage space for test leads and AC power cord. The DMM includes a fuse and over-voltage protection. Test leads, an AC power cord, straps and a manual are included.

The *Model 2835* DMM is priced at $270.

B + K Precision
Maxtec International Corp.
6470 Cortland Street
Chicago, IL 60635
Phone: 312-889-9087
Fax: 312-794-9740.

COMBINED DIGITAL STORAGE OSCILLOSCOPE, LOGIC ANALYZER, AND MULTIMETER. This instrument combines a 50-megasample per second digital-storage oscilloscope, 50-MHz logic analyzer, and a 4000-count digital multimeter. The Model 3850 from *HC Protek* has a 3 × 4-inch LCD screen and an RS-232C interface.

The dual-channel scope, with 8-bit resolution and autoranging can store 15 traces and cursors to indicate time, voltage, and frequency. The logic analyzer can accept 16 channels of input, and the multimeter has a 3¾ digit LCD display with a bargraph.



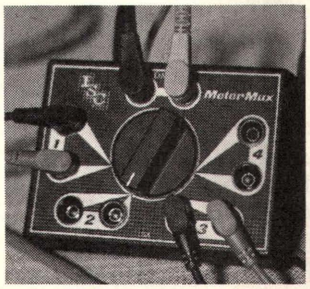
CIRCLE 23 ON FREE INFORMATION CARD

The DMM makes all standard DMM measurements plus frequency, and capacitance; it also tests diodes and does audible continuity checks.

The Model 3850 is priced at $1349.

H.C.Protek, Inc.
P.O. Box 59
Norwood, NJ
Phone 201-767-7242
Fax: 201-767-7343

DIGITAL MULTIMETER INTERFACE MODULE. This module permits up to four lead pairs to be multiplexed to a single multimeter. A rotary switch on the *MeterMux from Innovative Solutions* selects the desired pair.

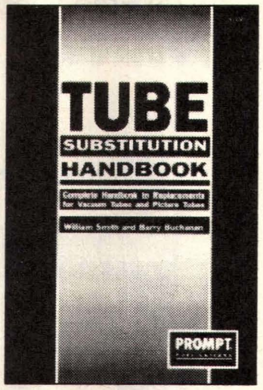


CIRCLE 24 ON FREE INFORMATION CARD

Compatible with all popular DMMs, it is offered in 4.4 × 3.3 × 1.5-inch benchtop or DIN-rail cases.

The benchtop *MeterMux* is priced at $48; the DIN-rail version is $56.

Innovative Solutions
416 Stewart Hollow Road
Portsmouth, OH 45662
Phone 614-574-4304. Ω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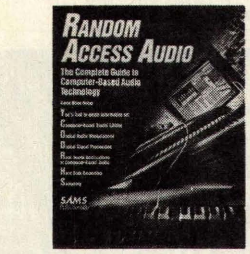
Random-Access Audio: The Complete Guide to Computer-Based Audio Technology; by David Miles Huber. Howard W. Sams & Company, 11711 North College, Carmel, IN 46032; Tel: 800-428-5331; Fax: 800-448-3804; $26.95.

This new book takes on the subject of digital audio and applications for that technology. After explaining the role of computers in music and recording applications, Mr. Huber describes the equipment, techniques, and processes needed for digital-audio productions. He emphasizes creativity and improving performance.



CIRCLE 25 ON FREE INFORMATION CARD

The author goes on to explain how musicians can use fast access, repeatability, and full system automation, and how to work with quantization, sampling, aliasing, and digital reproduction. Hard-disk recording systems, multimedia production, and random-access audio from broadcast stations are other subjects described.

Test & Design Instrumentation Catalog; Global Specialties, 70 Fulton Terrace, New Haven, CT 06512; Phone: 203-466-6103; Fax: 203-468-0060; free.

Test & Design
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CIRCLE 26 ON FREE INFORMATION CARD

Global Specialties' 1993 catalog contains listings of the frequency counters, pulse generators, power supplies, logic probes, and solderless breadboards it is offering.

New products introduced in the catalog include a programmable bench power supply, a sweep-function generator, an intelligent universal counter/timer, and a portable design workstation.

The catalog includes an instrument selection guide, and a chart that compares specifications and leading data on all instruments described in the catalog.

File & Disk Management: From Chaos To Control; by Alfred Glossbrenner. Osborne McGraw-Hill, 2600 Tenth Street, Berkeley, CA 94710; Phone: 510-549-6600; Fax; 510-549-6603; $39.95 (including 3.5-inch disk).

This combined book and disk is a complete educational package intended to help you to maximize the performance, capacity, and security on any hard drive in your personal computer.

Mr. Grossbrenner starts with the basics by explaining how a hard drive works, and how and where to buy the optimum drive for your specific personal computing needs. The author then discusses hard-drive installation in detail, and follows it up with step-by-step instructions on the best way to prepare, set up, load, and organize your hard disk.

Other topics covered in the book include how to use DOS, menus, shells, and front ends. It also includes clever batch file tips. A ten-step procedure that can nearly double your disk space is revealed. And you'll find a wealth of pointers on how to adjust your drive to maximize speed.

FILE & DISK MANAGEMENT
TO CONTROL

CIRCLE 27 ON FREE INFORMATION CARD

The enclosed 3.5-inch disk is loaded with software utilities and tools. These include McAfee's Anti-Virus Package and DIET, the DOS-compatible file shrinker. It also includes ORG for boosting a hard disk's performance and PLUS, a collection of tools for disk housekeeping.

ARRL Technician Class Exam Video Course; The American Radio Relay League, 225 Main Street, Newington, CT 06111; Phone: 203-666-1541; Fax: 203-665-7531; $99 ($119 with optional computerized exam review).

Exam Course

CIRCLE 28 ON FREE INFORMATION CARD

The ARRL Technician Class Exam Video course will help you to pass the required Federal Communications Commission (FCC) examination for technician rating. It includes five hours of videotape and a review book. An optional practice exam or a floppy disk is available as an option.

The disk administers and scores sample tests based on the the same pool of questions that the FCC draws on to make up its exams. The course was produced by King's School of San Diego, CA. That school has applied the same instructional techniques to help hundreds of thousands of private airplane pilots pass their Federal Aviation Administration (FAA) pilot's license examinations.

Troubleshooting and Repairing Audio Equipment, Second Edition; by Homer L. Davidson. Tab Books Inc., Blue Ridge Summit, PA 17294-0850; Phone: 1-800-233-1128; $19.95.

This book reveals many of the secrets of professional audio equipment servicing. Mr. Davidson tells you how to locate, diagnose, and repair problems

Continued on page 90

DRAWING BOARD

Unlocking the secret software passage.

ROBERT GROSSBLATT

The shareware debuggers described here last month are posted on the *Electronics Now BBS* (516-293-2283, 1200/2400, 8N1). Although they are nice pieces of software, we've received many requests for information on commercial debuggers.

There's certainly no shortage of commercial debuggers on the shelves of your local software store, but Codeview and Periscope are the only ones I've really spent any time with. The current generation of debuggers are all what the companies who make them like to refer to as "feature rich." That's both good news and bad news.

The good news is that a commercial debugger will have the muscle and subtlety to do whatever you need it to. The bad news is that the more powerful the software, the steeper the learning curve. For that reason alone, it's a good idea to pick your debugger carefully. Because you'll have to make an enormous investment in time to become proficient in using the software, make sure the debugger you choose is the one that's going to do the job you have in mind.

I've been using Periscope for years, and I have never regretted the time and money I invested in it. The memory overhead it requires is minute and, at a basic price of about $300, it's a good deal. Some people prefer Codeview. It's a good product as well, but one of the major strengths of any software is the level of support the buyer can get from the manufacturer. In my experience it's a lot easier to get a person on the phone when you call the Periscope Company than it is when you call Microsoft to get help with Codeview.

If you call Periscope, you'll find that they have a wide range of products available ranging from a software-only package at about $300 to hardware/software combinations that are a lot more powerful—but for a lot more money. If you're in the business of writing software, you'll find that Periscope will earn its keep the first time you use it to figure out why your code keeps crashing. You can get in touch with the Periscope Company at 1475 Peachtree Street, Suite 100, Atlanta, GA 30309 (404) 888-5335. But back to the business at hand.

LISTING 1

```
2BC0:1900 55            PUSH BP           ;Save the register
2BC0:1901 50            PUSH AX           ;Save the register
2BC0:1902 9AB3194F55    CALL 554F:19B3    ;Show the company logo
2BC0:1907 9AC6304F55    CALL 554F:30C6    ;Play some music
2BC0:190C 9A965D4F55    CALL 554F:5D96    ;Do a doc check
2BC0:1911 9A3ADB4F55    CALL 554F:DB3A    ;Go to the game
```

If you've been doing your homework over the last month, you've gained some experience tracing through the kind of code you see when you do a dump in DEBUG. The pages and pages of disassembly seem to be meaningless at first but, if you stick to it, you'll find that there's an underlying rhythm to it all.

Most programs start off with a bunch of setup instructions followed by either a jump table or a sequence of CALLs for displaying the company logo on screen, starting the music, and so on. With any luck, the CALLs would be in the same order as the list of events you wrote down. If that's the case, you will sooner or later come across code that looks something like Listing 1, without the comments, of course. The addresses and details of each instruction would undoubtedly be different.

As discussed last month, you should break into the debugger after the company logo appears on the screen, and trace back until you find the CALL that executes that part of the code. If the CALL is followed by a sequence of other CALLs (as shown in Listing 1), just try each of the CALLs to find the one you want.

With your fingers crossed, call up the JUMP instruction of our debugger and execute the CALL at offset 1907. After a few tense milliseconds, the catchy jingle from the game might come blasting from the speaker. After treasuring a victorious moment of earned pleasure, get back into the debugger and go back to the table you found.

Executing the CALL at offset 190C will take you, just as expected, to the screen that's used for the document check—and there's the cursor just waiting for you to look up a number from a table in the manual and enter it. "Look this up!" you say with a smirk on your face, and with supreme confidence you Jump to the CALL at offset 1911. The screen clears, and the opening screen from the game appears with its usual message telling you to "Press Any Key to Continue."

You press the Return key and your jaw drops; instead of getting into the game, you see a familiar message saying that "That's Not the Code Number I Want" and you're unceremoniously dumped back into DOS. What's going on?

While the practical result of this message is that you're going to be up all night, the reason for its appearance is that there's more going on in the document-check routine than you thought when you first found it. Obviously, the program is looking for something that was supposed to happen during the routine. Since your way of dealing with the copy protection was to bypass it altogether, what was supposed to happen there was bypassed by the routine as well.

When you run across situations like this, the usual reason is that a successful completion of the document check (reading the correct number from the correct table on the correct page in the manual and entering it correctly at the keyboard) sets a flag somewhere in memory that tells the program to go into the game. When the document check is bypassed, the flag isn't set, and instead of going on to save the earth from an invasion by politically correct aliens, you're staring at a DOS prompt.

To figure things out, you'll have to trace through the document-check routine whose starting address you found in the jump table. This time around, you'll have to look for different code than you did when you were searching for CALLs. As you trace into the document-check routine, keep an eye out for CALLs as you did earlier, but also watch out for code that looks like that shown in Listing 2.

Whenever you run across a CALL, write down the address, execute the CALL, and observe what happens. More than likely you'll run across routines that do things such as pausing for keyboard input, storing an entered string in a memory buffer, or calculating checksums. These are all part of the larger document-check routine that collects and checks the validity of what you type at the keyboard. But no matter how fancy the document check is, its only job is to give a go/no-go indication to the rest of the program. And in most cases, that indication is marked by having a particular bunch of bytes stored in a particular memory location.

The line of code in Listing 2 is important because it's where the successful completion of the document check is marked. Instructions such as the one shown in Listing 2 will stand out like a sore thumb if they're preceded by stuff like that shown in Listing 3.

Notice the series of instructions that come before the MOV instruction at offset 62BA. A lot of things have to happen successfully for that instruction to be executed at all. Storing a 1111 at location 1C32h is the key to the siccessful completion of the document check. All the code in the routine is aimed at the rest of the game seeing a 1111 there, (meaning that correct code was entered from the table in the manual) or something else at 1C32h (meaning that incorrect code was entered and the user failed the document check).

Being able to spot this kind of code is partially due to luck, partially due to experience, and often results from an educated guess. There will always be lots of false tries before you find the one (or more than one) solution that works. In general, keep an eye out for lines of code that put hard numbers in absolute locations low down in the memory map. Most games are written in high-level languages such as C, and it's standard programming practice to declare variables early on in the code. That's what was done in our example here.

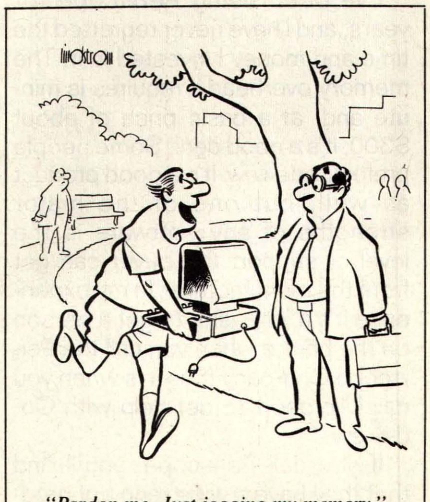
Once you find the key, it's a simple matter to check and see if it works. Go back into the debugger, manually stuff a 1111 into location 1C32h, and execute the CALL at offset 1911. If the screen clears and you see a shipload of aliens speeding to the earth, you can hit the sack and get some rest, secure in the knowledge that the hardest part of defeating the document check is behind you. Next time we'll see how to make it permanent. Ω

LISTING 2

```
4F1C:62BA C706321C1111          MOV WORD PTR [1C32],1111
```

LISTING 3

```
4F1C:6290 3B46E0          CMP AX,[BP-20]
4F1C:6293 7505            JNZ 629A
4F1C:6295 C746DEFFFF      MOV WORD PTR [BP-22],FFFF
4F1C:629A EB00            JMP 629C
4F1C:629C 837EDE00        CMP WORD PTR [BP-22],+00
4F1C:62A0 7402            JZ 62A4
4F1C:62A2 EB0C            JMP 62B0
4F1C:62A4 FF46D6          INC WORD PTR [BP-2A]
4F1C:62A7 837ED602        CMP WORD PTR [BP-2A],+02
4F1C:62AB 7D03            JGE 62B0
4F1C:62AD E937FD          JMP 5FE7
4F1C:62B0 837EDE00        CMP WORD PTR [BP-22],+00
4F1C:62B4 7504            JNZ 62BA
4F1C:62B6 0E              PUSH CS
4F1C:62B7 E8E8FC          CALL 62A2
4F1C:62BA C706321C1111    MOV WORD PTR [1C32],1111
```



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BUILD A DIVERSITY ANTENNA AND IMPROVE THE PERFORMANCE OF ANY CAR STEREO!

Eliminate multipath noise from your FM radio as you drive with this diversity circuit that switches antennas.

WHEN LISTENING TO AN FM STATION in your car, have you ever noticed the sudden onset of noise —pops, clicks and hum—that lasts for just a short time? Maybe you stopped at a traffic light, heard the interference, but found that it disappeared when you drove away—less than a car length.

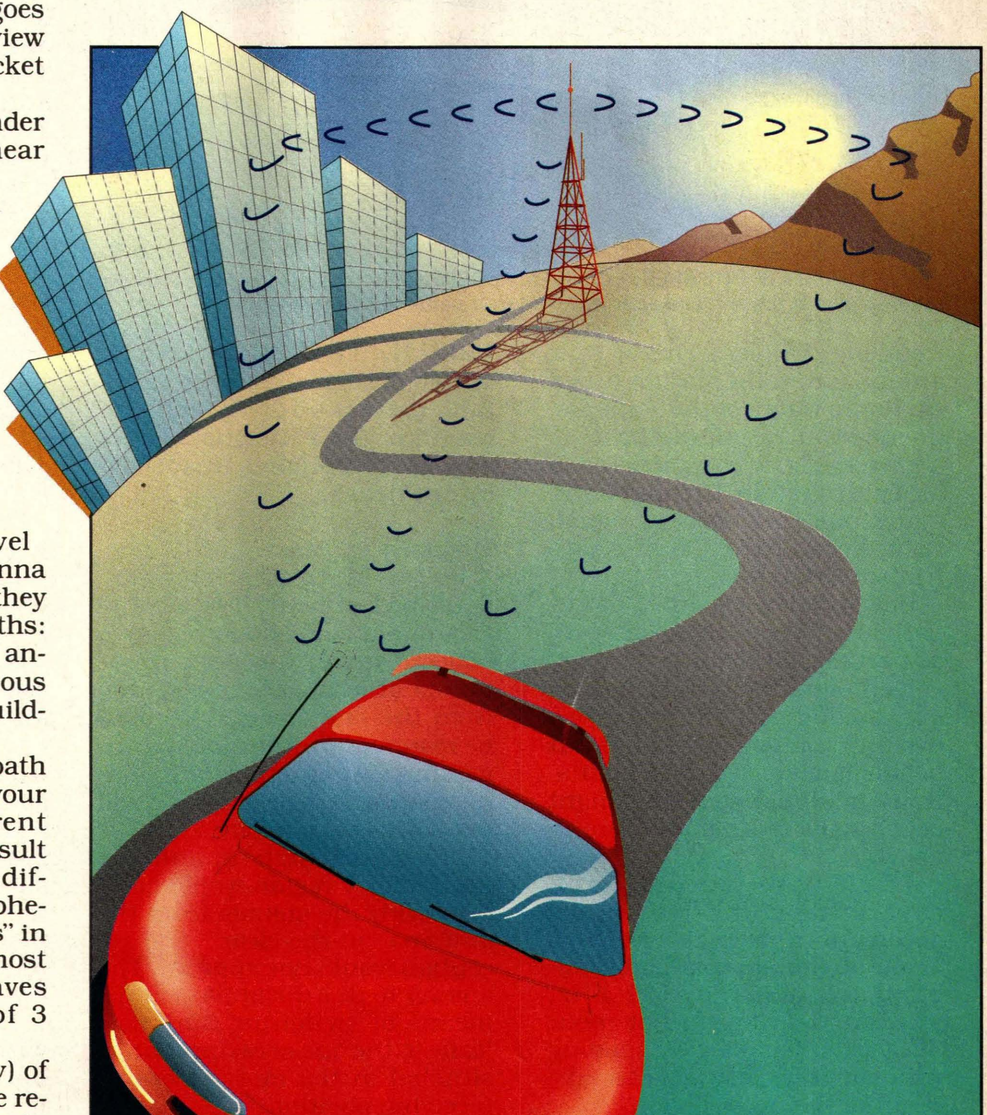
This audio annoyance could be caused by local sources of noise, or it could be caused by *multipath*—the convergence of FM signals at your car's antenna that arrived by taking different paths from the FM transmitting antenna. The interference is commonly called "picket fencing" because it comes and goes as you drive, much as your view changes as you walk by a picket fence.

You could be stopped under overhead power lines or near neon lights, motors or relays that could introduce noise into the FM receivers of even the latest model, high-priced cars. However, if you look around and find no obvious sources of electrical noise, consider the possibility that the interference is caused by multipath.

As FM radio waves travel from the transmitting antenna to your receiving antenna, they can take many different paths: Some travel directly to your antenna; others take more devious routes as they bounce off buildings, hills or mountains.

Figure 1 illustrates multipath radio waves converging on your car's antenna with different phase relationships as a result of traveling over paths of different lengths. This same phenomenon can cause "ghosts" in television reception. It is most noticeable with radio waves that have wavelengths of 3 meters or less.

The strength (and quality) of the received FM signal is the resultant of the phase and amplitude of all the waves at the same



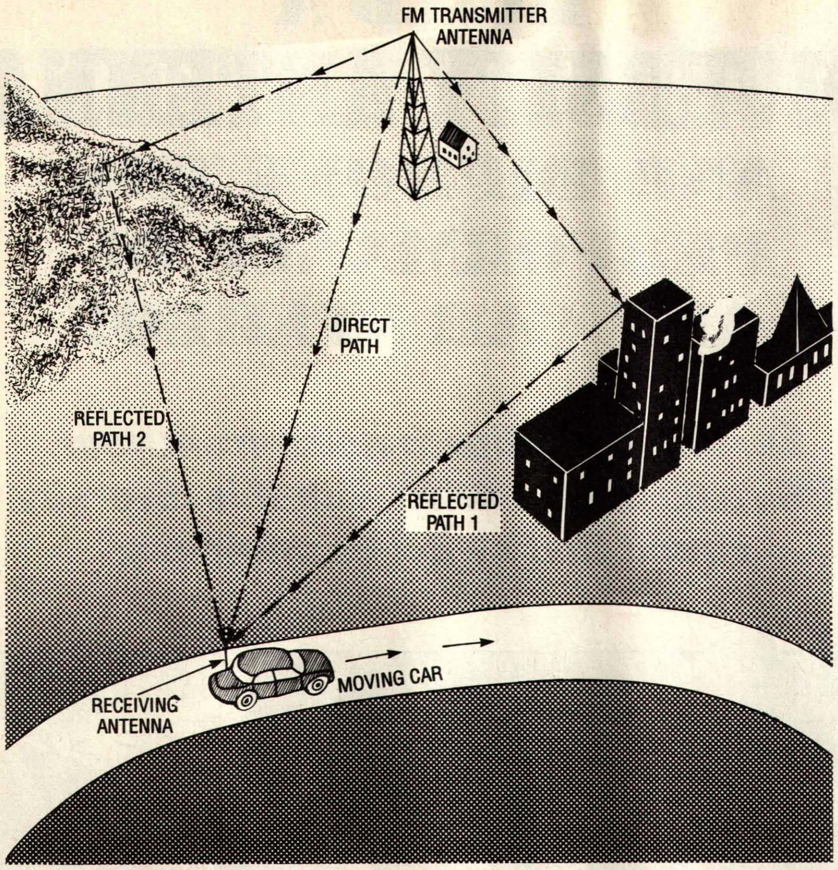


FIG. 1—MULTIPATH INTERFERENCE IN FM RECEPTION is caused by signals arriving out-of-phase at the antenna after traveling over paths of different length.

frequency which arrive at your antenna from the station tuned in. Radio waves of the same frequency that are out-of-phase, as shown in Fig. 2, can cancel each other in certain locations and blank out the received signal, regardless of the FM station's transmitter power.

However, the effects of multipath are more likely to show up as partial cancellation of the received signal accompanied by extraneous noise. If you keep driving, you will soon pass out of this "noisy" region. Fluctuations in signal strength might occur just a quarter wavelength apart.

The FM broadcast band covers the radio-frequency spectrum from 88 to 108 MHz. Thus at the approximate mid-band frequency of 100 kHz, wavelength is 3 meters or about 3¼ yards. That's why moving your car only a few feet can take it out of the noise region.

By contrast, the amplitude-modulated (AM) broadcast band, covers the much lower frequency spectrum of 540 to 1600 kHz. Thus at 1000 kHz, an AM signal has a wavelength of 300 meters—100 times the length of the FM signal. That's why AM reception is unaffected by multipath.

Diversity systems

In the FM reception situation described, if instead of moving the car out of the noisy region, a second antenna were positioned at least 30 inches away from the first, reception could be restored. Unfortunately, connecting two antennas simultaneously to a single car radio will not solve the problem.

The signals from the antenna in the noisy region would combine with the signals from the antenna "in-the-clear," and reception would not improve. The answer to this dilemma is find a means of switching automatically to the one of two antennas situated in the most favorable receiving position.

There is nothing new about the concept of switching antennas to improve reception. One method called *diversity reception* was developed in the early days of radio to counter the effects of "fading" in shortwave reception. Shortwave or high-frequency (HF) signals, are capable of traveling thousands of miles by "bouncing" off ionized layers 100 kilometers or higher in ionosphere. They were once the best method for long-range communication, and fading could break that communications link.

In those early high-frequency diversity systems, two separate antennas positioned several miles apart fed two separate receiver sections. Electronic circuits compared the relative strengths of the two received signals, and automatically selected the strongest for further amplification and reception. The selection was performed by automatic gain control (AGC). The output DC level was proportional to the strength of the signal being received.

The same circuitry could improve mobile FM reception, but two complete receivers would be required—obviously impractical and expensive. Moreover, opening a standard automotive receiver case to add circuitry could pose a problem due to space and power limitations. The circuit described in this article solves that problem.

A novel FM system

In stereo FM broadcasting, the transmitter encodes left and right channels as sum and difference signals. The difference signal, L – R, modulates the 38-kilohertz sub-carrier necessary for decoding the stereo channels at the receiver. It is not transmitted because of bandwidth restrictions. Instead, the FM station transmits a *pilot subcarrier* at 19 kilohertz, half the subcarrier frequency. This pilot phase locks a 38-kilohertz oscillator in the receiver to decode the stereo signal.

The 19-kHz pilot subcarrier is within the audio bandwidth, but its amplitude is so low that it doesn't disturb the listener. However, the presence of this pilot subcarrier makes possible the FM diversity reception system discussed in this article.

The FM diversity circuit monitors the 19-kHz pilot subcarrier signal.

Steadiness of the reception of this 19-kHz pilot signal in the audio portion of the FM transmission is an indication of the quality of the received signal. Whenever this signal falls below a specified threshold value, it will be lost in background noise. The threshold establishes the criterion for switching antennas. In effect, the pilot threshold level functions in FM diversity as the AGC level functions in HF diversity.

How FM diversity works

A second antenna, installed on your vehicle as far away from the original equipment antenna as practical, provides the second FM signal. Figure 3 is a simplified block diagram of the diversity system.

The cables from both antennas are connected to the electronic antenna switch. The 19-kHz pilot signal from the receiver's audio output is passed through a high-gain bandpass active filter which attenuates audio programming that is much stronger than the pilot signal. After amplification, the pilot subcarrier becomes the reference frequency for a phase-locked loop (PLL) circuit. The output of the PLL locks to the 19-kHz pilot signal and functions as a subcarrier detector.

When the reference frequency becomes noisy, the PLL will lose "lock" and trigger the flip-flop whose output switches the state of the electronic antenna switch. This action switches the alternate antenna into the system while disabling the original antenna.

If that second antenna is positioned for better reception, the received signal will clear, and the PLL will again lock to the subcarrier and hold the switch in that state until the pilot signal drops out again. If the second antenna does not restore the pilot signal reception after a 0.1 second delay, the primary antenna is switched back on.

When the radio is receiving AM, the absence of a 19-kHz subcarrier will also reactivate the primary antenna that is tuned to the receiver for the best AM reception.

FM diversity circuit

Refer to schematic diagram Fig. 4. The audio signal from the FM receiver appears at connector J4. The two capacitors C11 and C16 in the audio input section bypass any DC components in the radio output or overvoltages that could be caused by miswiring. Trimmer potentiometer R22 controls the input level. The LF347 quad operational amplifier IC3 is an active filter with a gain of 50 at 19 KHz. It has four sections: a, b, c, and d.

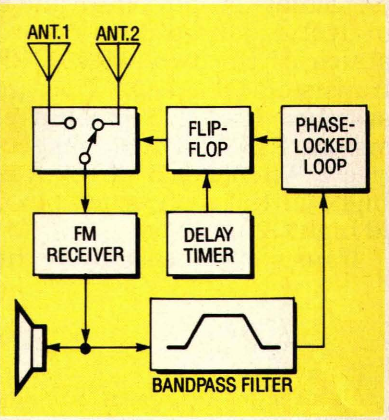


FIG. 3—BLOCK DIAGRAM OF THE FM DIVERSITY SYSTEM to overcome multipath interference or cancellation.

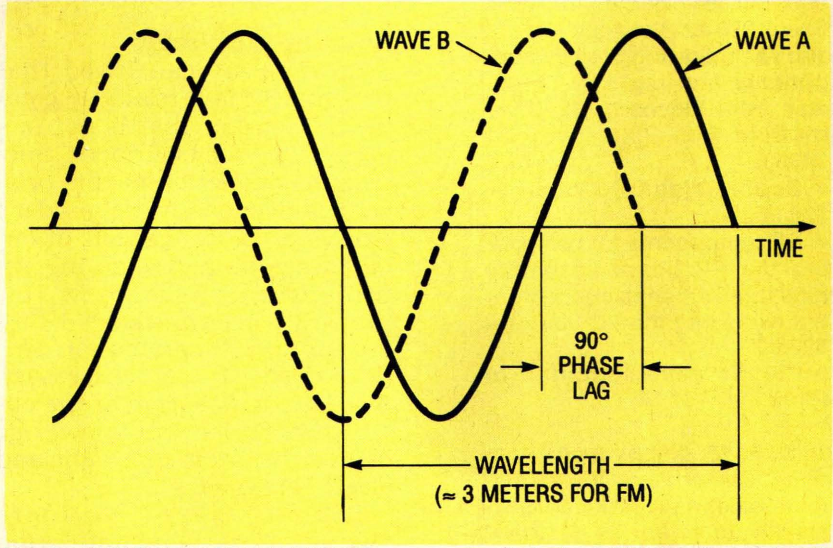


FIG. 2—OUT-OF-PHASE SINE WAVES represent out-of-phase FM signals arriving at a receiving antenna. They can combine constructively or destructively. An FM signal is about 3 meters long.

The active filter attenuates the audio so that the LM1800N phase-locked loop (PLL) IC1 can lock onto the 19-kHz pilot subcarrier. With 2 millivolts input, the output level at pin 14 of IC3-d is about 100 millivolts. Light-emitting diode LED3 is the level indicator for IC3-d. Each of the four 47,000-ohm feedback resistors, R1, R6, R7, and R8, around the op-amp sections in IC3 has a 1% tolerance. The feedback capacitors (reading from left to right) C6, C4, C19 and C23, and the input capacitors C7, C5, C20, and C21 have closer 10% tolerances to assure that the filter will tune in the 19-kHz region.

Trimmer potentiometer R21 (in series with resistor R10 at frequency pin 15 of IC1) sets the PLL's operating frequency to 19 KHz. Resistor R9 and capacitors C2 and C12 form the loop filter between pins 13 and 14 of IC1 to set the PLL's locking characteristics including *capture time* and *capture range*. The values shown result in a 1-millisecond capture time and 2-kHz bandwidth. Bandwidth is not critical in this circuit because the center frequency is always 19 kHz. However, the wider the bandwidth, the faster the capture.

Every time the PLL locks to the incoming signal, it produces a low-level logic output at LAMP pin 7 of IC1. When the input signal is lost, pin 7 of IC1 goes high, toggling 74C74 CMOS dual flip-flop IC2-a. Complementary output pins 5 and 6 of IC2-a control the ON/OFF states of the two MR901 RF transistors Q1 and Q2. They are switched through 33-kilohm resistors R13 and R12, respectively. When Pin 5 of IC2-a is high, Q1 turns on; when pin 6 id high Q2 turns on.

Transistors Q1 and Q2 are the active components in two identical broadband, untuned, common-emitter amplifiers. Each has a gain of about unity in the AM broadcast band and about 6 dB in the FM band. That 6-dB gain overcomes cable and connector losses. The low AM gain prevents AM signal overload.

Transistor Q1's base is connected to antenna input jack J3 for Antenna 1 and transistor Q2's base is connected to input jack J3 from antenna 2. The transistor collectors are connected, but only one transistor can be turned on at a time. As a result, the circuit works as a fast electronic single-pole, double-throw antenna switch.

The load inductance for Q1 and Q2 presents a high impedance at FM frequencies for good amplification. However, at AM frequencies this impedance is low, resulting in low amplification. The output signals at Q1 and Q2 feed back to the working antenna input jack.

The second half of the CMOS dual flip-flop IC2, section b, is a 0.1-second timer. If the FM pilot subcarrier is absent for more than 0.1 second, 0.1µF capacitor C17, charging through 1-megohm resistor R15, toggles flip-flop IC2-b, forcing pin 8 low. That low output presets the IC2-a flip-flop, biasing Q1 ON and activating antenna 1. This feature is necessary for AM operation because antenna 1 is the car's original equipment or primary AM antenna.

Flip-flop IC2-a also forces Q1 on for non-stereo FM signals. The illumination of PILOT LED 3 indicates that the PLL is locked to the pilot signal. The illumination of ANT 1 LED2 indicates that antenna 1 is active, and the illumination of ANT 2 LED1 indicates that antenna 2 is active.

Building the circuit

Readers are cautioned that this project is a relatively complex RF circuit that is not recommended for beginners. Successful completion of this project will depend on the builder's skill and the care taken in circuit assembly and soldering. An understanding of how improperly placed and soldered RF components can cause undesirable feedback is necessary. Also, the installation of the circuit calls for current knowledge of modern automotive radio and electrical systems.

Even seasoned builders should pay particular attention to details and work cautiously, especially in the RF adjustment,

PARTS LIST

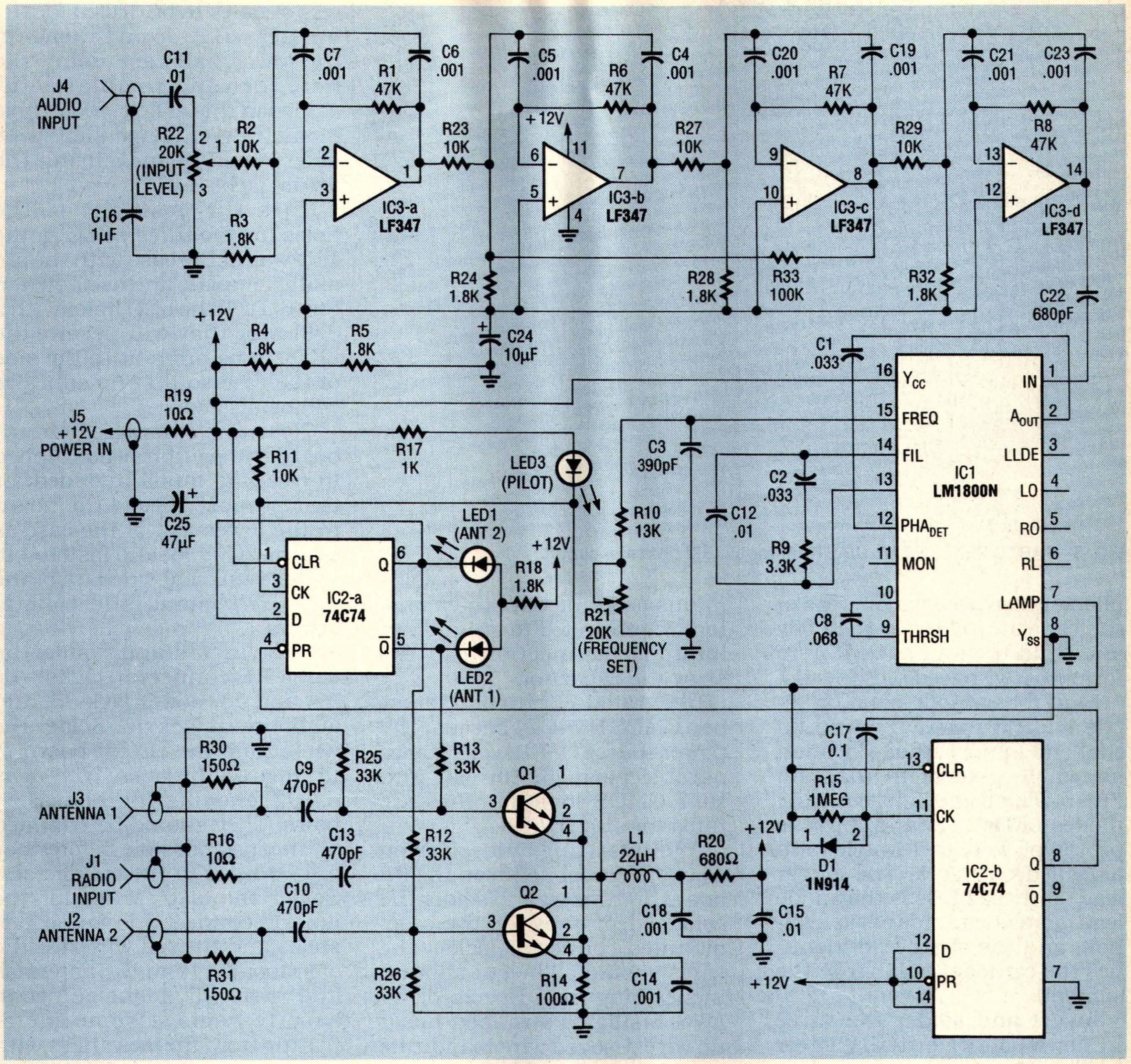
All resistors are ¼-watt, 5%, unless otherwise specified.
R1, R6, R7, R8—47,000 ohms, 1%
R2, R11, R23, R27, R29—10,000 ohms
R3, R4, R5, R18, R24, R28, R32—1800 ohms
R9—3, 300 ohms
R10—13,000 ohms
R12, R13, R25, R26—33,000
R14—100 ohms
R15—1 megohm
R16, R19—10 ohms
R17—1000 ohms
R20—680 ohms
R21, R22—20,000 ohms trimmer potentiometer, PC mount, top adjust, Spectrol 321 or equivalent
R30, R31—150 ohms
R33—100,000 ohms
All capacitors are 20%, 25-volt, unless otherwise specified
C1, C2—0.033 µF
C3—390 pF
C4, C5, C6, C7, C19, C20, C21, C23—0.001 µF, 10% polyester film.
C8—0.068 µF
C9, C10, C13—470 pF ceramic disc
C11, C12, C15—0.01µF
C14, C18—0.001 µF ceramic disc
C16—1.0 µF
C17—0.1µF
C22—680 pF
C24—10 µF solid tantalum electrolytic
C25—47 µF solid tantalum electrolytic
Semiconductors
IC1—LM1800N phase-locked loop, National Semiconductor or equiv.
IC2—74C74 CMOS B dual flip-flop, National Semiconductor or equivalent
IC3—LF347 BiFET quad operational amplifier, Motorola Semiconductor or equivalent
Q1, Q2—MR901 or MR911 RF NPN transistor, Motorola or equivalent.
D1—IN914 silicon diode
LED1, LED2, LED3–light-emitting diodes, T-1 package, red, green, yellow

Other components
L1—22 µH RF choke
J1—power jack—Radio Shack 274-1565 or equivalent
J2—phono jack, RCA style
J4, J5, J6—Antenna connectors
Miscellaneous: automotive antenna, Motorola type; cigarette-lighter power cord (Radio Shack 270-1533-C or equiv.); plastic case (Serpac No. 132from Serco); extension cable, male-to-male (Radio Shack 12-1314 or equiv.); extension cable, male-to-female, 12-foot, (Radio Shack 12-1311 or equiv.); audio cable, RCA phono-type; one 14-pin DIP socket; two 16-pin DIP sockets; hook-up wire, stranded, insulated 24 or 26 AWG; plastic clamp (Radio Shack 278-1641 or equiv.); solder.
Optional miscellaneous: adhesive-mount automotive adhesive antenna (Radio Shack 12-1325 or equiv.); automotive antenna (No. 03CH7516N, J.C. Whitney, P.O. Box 8410, Chicago IL 60680 (312) 431-6102); miniature power plug (Radio Shack 274-1567 or equiv.); fuse holder, in-line (Radio Shack 270-1213 or equiv.).

Note: The following project components and parts are available from Videoart, 4123 Middlefield Rd., Palo Alto, CA 94303:

- **Double-sided PC board—$28.00**
- **All components for completing the PC board assembly plus three antenna connectors but excluding the PC board)—$23.00**
- **Plastic case specified in Parts List—$7.50**

Add $6.50 for shipping and handling. California residents add local sales tax. Make all payments as either in certified check or money order. Please allow 4 to 6 weeks for delivery.


J4
AUDIO
INPUT
C11
.01
R22
20K
(INPUT
LEVEL)
R2
10K
R3
1.8K
C16
1µF
C7
.001
R1
47K
C6
.001
IC3-a
LF347
R23
10K
C5
.001
R6
47K
C4
.001
+12V
IC3-b
LF347
R27
10K
C20
.001
R7
47K
C19
.001
IC3-c
LF347
R29
10K
C21
.001
C23
.001
R8
47K
IC3-d
LF347
R24
1.8K
R28
1.8K
R33
100K
R32
1.8K
C22
680pF
+12V
R4
1.8K
R5
1.8K
C24
10µF
C1
.033
R19
10Ω
J5
+12V
POWER IN
R11
10K
R17
1K
LED3
(PILOT)
C3
390pF
C25
47µF
LED1
(ANT 2)
R10
13K
C12
.01
C2
.033
R9
3.3K
IC1
LM1800N
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IC2-a
74C74
R18
1.8K
R21
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C8
.068
LED2
(ANT 1)
R30
150Ω
R25
33K
C9
470pF
R13
33K
J3
ANTENNA 1
Q1
R16
10Ω
C13
470pF
R12
33K
J1
RADIO
INPUT
C10
470pF
Q2
J2
ANTENNA 2
R31
150Ω
R26
33K
L1
22µH
R20
680Ω
C18
.001
C15
.01
R14
100Ω
C14
.001
C17
0.1
R15
1MEG
D1
1N914
IC2-b
74C74
+12V

FIG. 4—SCHEMATIC DIAGRAM for the FM diversity circuit.

test and installation phases of the project. Experience in working on automotive electrical and entertainment systems will be helpful.

Because the circuit must receive clear high-frequency FM signals, PC board construction is recommended. A partial kit, including an etched and drilled double-sided PC board with a ground plane, is available from the source given in the Parts List. Foil patterns are provided for those who want to make their own boards.

The ground plane is copper foil laminated over most of the component side of the board to ensure stable RF reception. It shields the active components to prevent inadvertent signal radiation, thus preventing unwanted oscillations. All of the electronic components are standard parts, stock items from mail-order distributors and most electronics retail stores.

All wiring must be as short as practical. For example, the leads of collector inductor L1 must be short to prevent unwanted oscillations. However, parts placement and wiring in the audio section is not critical.

Refer to both the schematic Fig. 4 and the parts placement diagram Fig. 5. Follow accepted parts placement practices, and do all soldering with a fine-tipped soldering pencil rated 30 watts or less, preferably with a temperature control set to 700°F. The cleanliness of the PC board and component leads is important for quality soldering. Be sure that all solder joints are smooth and shiny; cold solder joints are usually dull gray and irregular.

Use sockets for the all ICs, and observe the location of pin 1 when installing all sockets. Mount the eight axial-leaded 0.001 µF polyester capacitors C4 to C7, C19 to 21, and C23, the 390 pF C3 and the 0.047 µF C8 vertically. With needle-nose

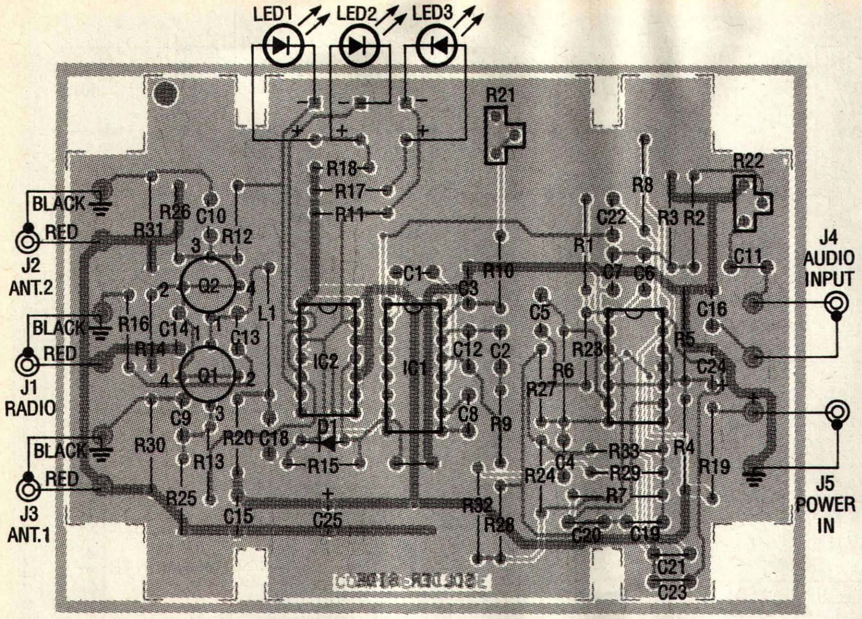


FIG. 5—**PARTS PLACEMENT DIAGRAM** for the FM diversity circuit.

pliers, grasp a lead at one end of the capacitor close to the body and bend the lead back 180° to form closely spaced radial leads.

Find the cathode band on diode D1 and insert the lead on that end in the cathode location shown in placement diagram Fig. 5. The three light-emitting diodes LEDs 1, 2, and 3 in the prototype were in T-1-style radial-leaded packages. The longer lead on these LEDs is the anode lead (arrowhead side of the symbol), and the short lead identifies the cathode lead (bar in the symbol).

Insert and solder the three LEDs without cutting their leads. Mount them so they stand off the board about 1¼-inches so the leads can be bent to insert the reflectors into the pre-drilled holes in the case after the completed board is mounted to the lower case half.

Transistors Q1 and Q2 have flat leads to minimize inductance. Position the transistors carefully on the board before soldering them. *Caution:* The transistors' orientation and spacing with respect to each other and the other RF components is critical.

Install the two polarized capacitors, tantalum dipped, radial capacitor C24 and aluminum electrolytic C25, according to the polarity marks shown on Fig. 5. *Caution:* Be sure the minus (−) side of both capacitors is connected to ground; an improper connection can destroy the capacitor.

Integrated circuit IC2 must be a CMOS B 74C74 because the power source is +12 volts. Comparable parts in the HC and HCT CMOS logic families are rated for only 5 volts.

After inserting and soldering all of the components on the PC board, cut, insert and solder the color-coded wires for the case-mounted connector jacks. The wires should all be cut about 3 inches long from No. 22 or 24 AWG insulated stranded hookup wire. Use red wire to indicate positive (+) and black to indicate negative (−) ground for power jack J5. Use any other color for the audio input signal to jack J4, but use black for the ground connection there also.

Insert and solder lengths of twisted black and red wire for the RF connector jacks J1, J2 and J3 with the red wires for the antenna and radio input signals and black wires for ground.

Packaging the circuit

The plastic enclosure specified in the Parts List is recommended because the circuit board described in this article is sized to fit snugly in it. Refer to Fig. 6 for the proper orientation of jacks with respect to the circuit board, and mark the centers of holes to be drilled for the five jacks J1 to J5 on the ends of the lower half case using the hole-forming templates included in this article. Exact hole diameter and shape should be determined by measuring the actual jacks.

Mark the positions of the holes for the three LEDs in the side wall of the case with the aid of the template and as shown in Fig. 6. Drill the LED holes with a drill size that will permit the LEDs to be press-fit in the side of the case so that no adhesive will be needed.

Clean the completed circuit board with cotton swabs dipped in cleaning fluids intended for that purpose. Insert the board in the lower half of the case as shown in Fig. 6, and fasten it to the two internal sidebars of the case with small sheet-metal screws.

Next, install and fasten the three RF connector jacks, J1, J2, and J3, power jack J5, and audio input jack J6. Solder the wires from the circuit board to the lugs on the jacks. Wire jacks J1, J2, and J3 with the twisted pairs. They should be trimmed as short as possible before they are soldered to the connectors. Solder the black wires for the ground connections to the jack shells and the red wires for the signal paths from the antennas and radio. (It might be necessary to remove some metal plating from the jack shells with emery cloth or a file to obtain a secure solder joint.)

Carefully bend both LED leads together so that the reflector body can be press-fit through the previously drilled holes on the side of the case.

Double check the completed assembly carefully. A magnifying glass will be helpful. Check for any incorrectly inserted components, solder bridges, or cold solder joints.

Identify all the jacks and LEDs on the outside of the case with a waterproof pen or dry transfer lettering. Label LED3 as PILOT, LED1 as ANT 2 and LED2 as ANT 1. Label J1 as RADIO INPUT, J2 as ANT 1 and J3 as ANT 2. Label J4 as AUDIO INPUT and J5 as "+12 V." Cover the labels with transparent tape or coat them with nail lacquer. Figure 8 is a photo of the author's assembled prototype.

Testing and tuning

Before applying power to the board, measure the resistance between the positive power supply connection and ground. It should be 3000 ohms or higher, after the filter capacitor charges. If it is lower, recheck the circuit for shorts or incorrectly installed ICs.

The power source required to perform these tests can be a 12-volt nickel-cadmium battery, a 12-volt lead-acid battery, or a 12-volt DC wall-outlet adapter. If you use an adapter, be sure it has a standard 2.1 millimeter diameter axial pin in the plug. Read the label on the adapter to be sure that the positive (+) conductor of the plug is the axial lead and the negative (−) conductor is the shell.

Put a ¼-ampere fuse in series with the power supply to prevent damage to the circuit if there are undetected shorts. An FM radio or tuner with an earphone or speaker plug connector is also required. The test setup shown in Fig. 7 emulates the wiring circuitry of an automobile installation.

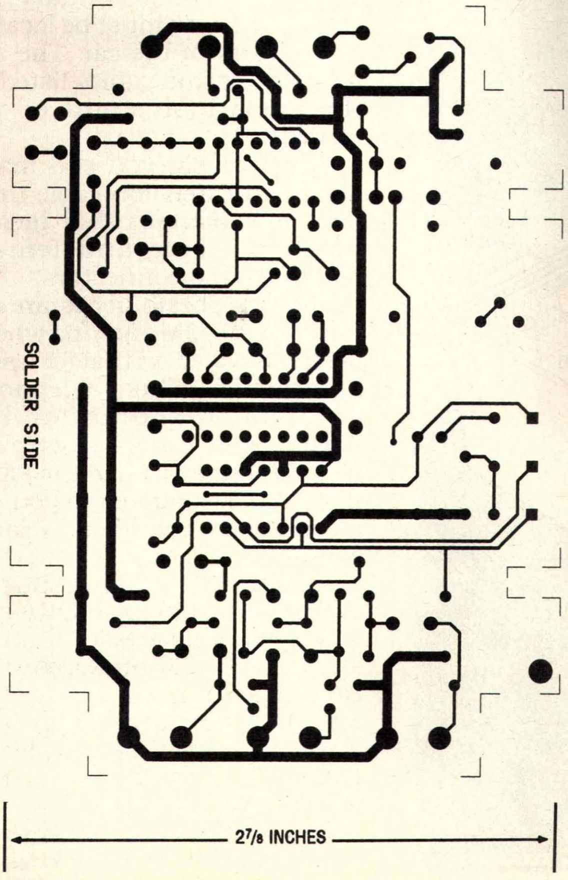
Tune the FM receiver to a stereo FM station. (The stereo indicator should be illuminated). Set the volume control from one quarter to one third of its maximum angle. Then connect the audio input of the diversity circuit to the FM radio's headphone or speaker.

Apply power to the system. With a plastic alignment tool or small screwdriver, adjust audio input-level potentiometer R22 to mid-position. Then adjust PLL frequency-set potentiometer R21 slowly until LED3 is illuminated. After this adjustment, LED3 will track the radio's stereo indicator to verify the presence of the stereo pilot subcarrier signal with different thresholds.

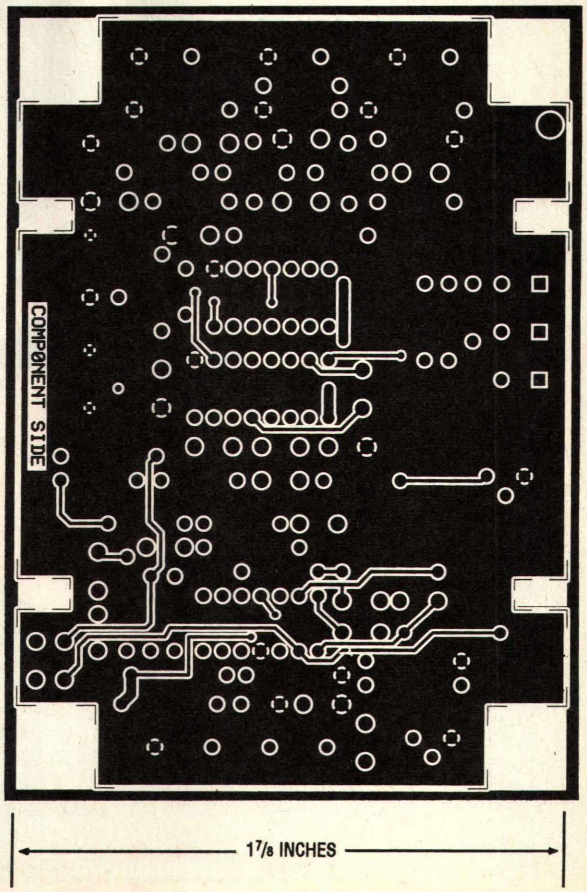
The radio indicator works with all stereo stations, and the diversity circuit depends on the audio volume and the setting of input-level potentiometer R22. Either LED1 or LED2 should be on. Turn down the volume control on the FM radio until LED 3 extinguishes. Observe the LED1 and LED2 pair: They should alternate between on and off each time LED3 goes out.

Turn the volume-control knob up and down to check the switching action. Turn the volume down once or twice so LED2 stays on, then keep the volume low. After 0.1 second, LED1 will light and LED2 will go off. That indicates the one-second timer is working.

Connect the RADIO INPUT cable from J1 to the FM radio's antenna input jack. If the existing FM radio receiver does not have external antenna connections, retract its antenna completely, and convert it to the input connection with wires connected by



FOIL PATTERN FOR THE COMPONENT SIDE OF THE PC BOARD.



FOIL PATTERN FOR THE SOLDER SIDE OF THE PC BOARD.

two alligator clips. The second connection is for ground, the outer part of the cable or jack.

Unless this connection is made with a coaxial cable, the antenna will not function correctly, and the test will be invalid. Light-emitting diode LED2 will be illuminated after the one-second timeout. Antenna 1 will be the active antenna. Conversely, LED1 will indicate that antenna 2 is active.

Connect two test antenna cables to their jacks in the diversity circuit. One of these could be the extra antenna you purchased for installation in your car. A three-foot length of insulated hookup wire stretched vertically will serve as the second antenna. Regardless of what you use as an antenna, it must make contact with the axial conductor of the connector. A banana plug can serve as a makeshift connector.

Tune in an FM station, check to see which LED is illuminated, and then disconnect the related antenna. This step will permit the circuit to switch to the alternative antenna, as shown by LED illumination. If the signal from the FM station selected is strong, switching action can be prevented if the antenna connections are not well shielded.

Choose a different station and repeat the test. Then repeat the test for the other antenna. Adjust the volume control to command antenna switching. When the desired LED turns on, remove the corresponding antenna, and the ability of the LEDs to turn on and off should be restored.

This test does not reproduce actual circuit operation because it is not possible to simulate, at a fixed location, the FM radio reception conditions to which your vehicle is exposed. In a car installation, the proper connectors and coaxial cables form well shielded connections without RF leakage. Nevertheless, this bench test can demonstrate that the RF switching is functional.

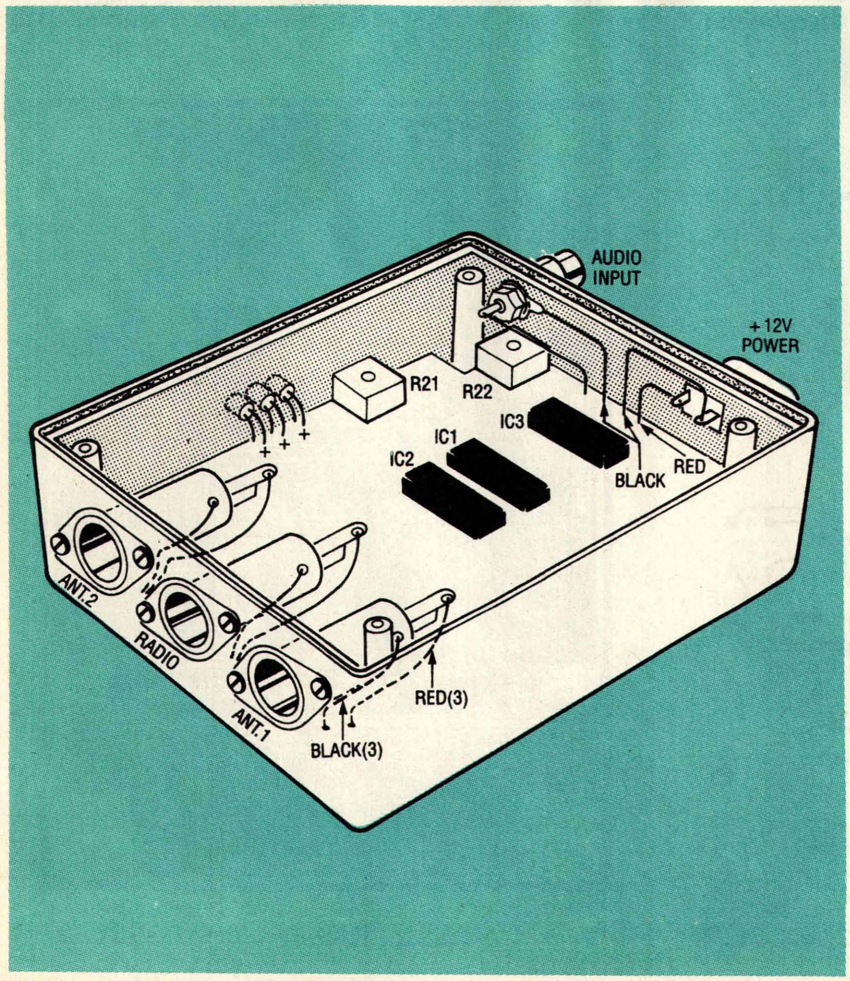


FIG. 6—ASSEMBLY AND WIRING OF CASE-MOUNTED components.

If you can perform this test with an actual auto radio receiver and the coaxial cables recommended in the Parts List, the test will still be a realistic approximation of an automotive installation.

Installation in a car

Refer again to Fig. 7, and install the second antenna on your car. The greater the separation between the primary and secondary antennas, the more effective will be the diversity circuit's operation. If, for any reason, you do not want to install a second full-size antenna, you can purchase a flat antenna that adheres to the windshield glass.

The cable from the originally installed antenna probably will not reach the diversity circuit unless the antenna was installed at the rear of the car. In that case, the secondary installed antenna must be located at the front of the car. The antenna extension cables listed in the Parts List might be required.

Alternatively, you can make your own extension cable from low-loss coaxial cable terminated by male and female Motorola-type connectors.

Another possibility is an automotive AM/FM antenna whose design is based on that for a surface-mount cellular telephone antenna. A source for the 03CH7516N antenna with 17 feet of cable is given in the Parts List. However, an extension cable will not be needed for most cars.

A horizontal antenna such as the windshield type mentioned will provide polarization diversity because FM broadcast stations transmit both vertically and horizontally polarized waves. This will be an advantage even if the two antennas are not very far apart.

Access to the radio's electrical connections in most cars can be gained by removing the front panel of the radio, and pulling it out to expose the antenna and speaker connections. Consult the maintenance manual for your car radio for details on how to remove the radio without damaging it.

The latest model car radios have RCA audio output connectors. Those will will make it easy to provide the audio for the diversity circuit.

Alternatively, the audio signal source will be the radio's speaker output terminals. Any of the stereo outputs will provide the signal depending, of course, on the stereo BALANCE control setting. Identify all of the speakers' terminals and wiring. Consult your user's manual or read the labels on the wires.

Radio manufacturers do not all follow a uniform wiring color code, so the functions of the wires cannot be determined reliably from their colors. However, several leading manufacturers have agreed on green and gray for the left and right speakers, respectively, and black for common or ground. The ground (or low side) goes to the ground side of the audio input jack of the diversity circuit. Only one audio source is required for the operation of this circuit.

Caution: Do not connect the unit to the output of an external power booster.

Unfortunately, you have no guarantee that your radio's power amplifier will have sufficient bandwidth to allow the 19-kHz subcarrier to pass. Tap the audio from the input cable to the power amplifier. If resistive "faders" have been installed, tap the audio signal upstream of them.

Any connections spliced to the speaker wires must be insulated with quality electric tape so they will not be shorted to ground. Connect the original equipment car antenna to the antenna input jack ANT 1. Then connect the second antenna to input jack ANT 2. Connect the diversity circuit to the FM receiver with an extension cable terminated by two male plugs, one end plugged into the RADIO INPUT jack.

The required 12-volt power can be obtained from a fused cigarette lighter adapter cable. Install a ¼- or ⅛ ampere fuse in the fuse holder to protect the diversity circuit. However, if you want a more permanent connection, you can make one with an in-line fused cable for the power connection to the spare lugs usually available in the car's fuse box. See the Parts List.

Turn on the receiver and plug in the adapter. Tune to a stereo station, and set the receiver for normal listening while driving. Readjust input-level trimmer potentiometer R22 for this normal audio volume setting in the car until LED3 remains on without blinking. Set the tone or treble control to at least one-quarter of a turn towards maximum. If this is not done, the 19 kHz pilot subcarrier signal will be too low. If LED3 doesn't light up, readjust the PLL frequency-set trimmer potentiometer R21 until it does.

Verify that LED1 and LED2 change state each time you lower the volume. Then change stations. That also will control the LED1 to LED2 switching. Input-level trimmer potentiometer R22 controls switching sensitivity. If it is set too low, LED3 will not light. Set it so LED3 remains on without blinking when a clear stereo station is being received. Trimmer R21 must be set in the middle of its "lock" range, the span between the two points in wiper rotation where LED3 turns on and off.

Check the 19-kHz pilot subcarrier level at the audio output of a receiver with a high-Q band-

continued on page 85

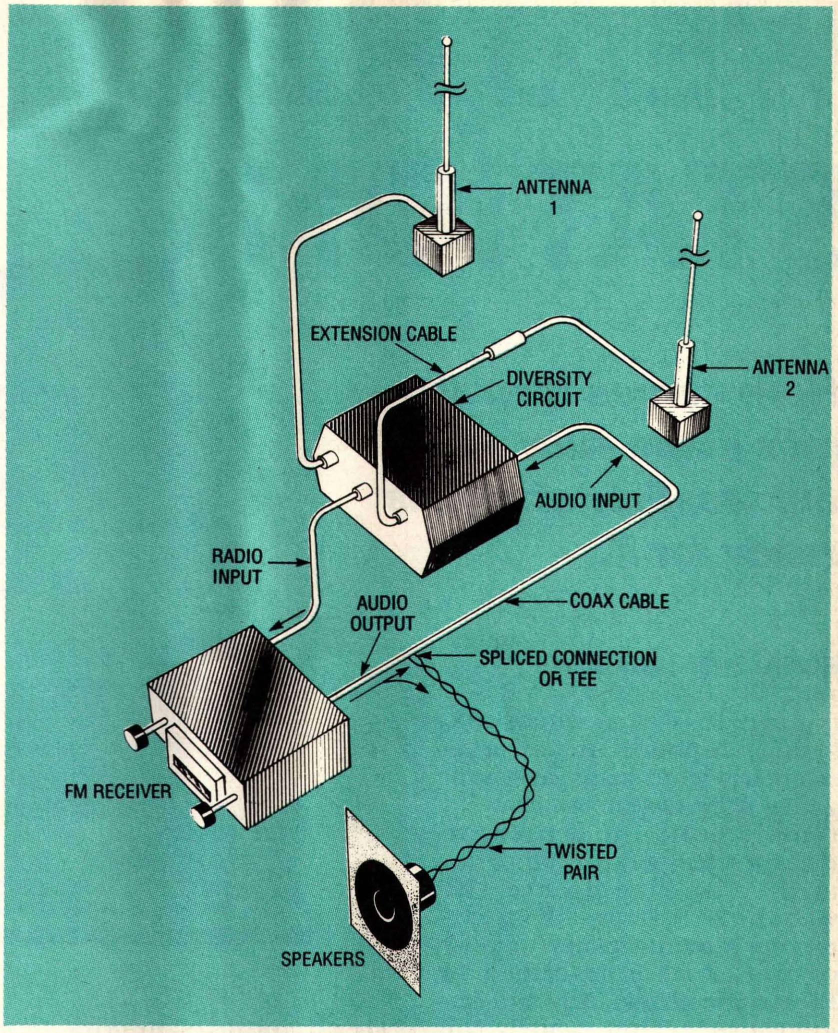


FIG. 7—THE FM DIVERSITY SYSTEM installed in an automobile with one antenna, a radio and speakers.

WEATHER STATION

Here comes the rain—let's make sure our weather station is ready for it.

RONALD M. JACKSON

IN LAST MONTH'S ARTICLE, CONSTRUCTION details for an anemometer, wind vane, and rain gauge were described. Now it's time to build the sensors to measure temperature and humidity and complete the weather station. Experimenter's connections to your computer were described in **Electronics Now**, July and August 1993. This month the weather station's connections to the Experimenter are described.

Air sensors

"It's not the heat, it's the humidity." Although sometimes it's both! But in either case, the weather station has the data you need. Five temperature sensors, with tenth-of-a-degree resolution, provide accurate temperature information. You can place one indoors, one outdoors, one upstairs, one downstairs, and one, perhaps, in the attic or deep freezer.

Two humidity sensors provide inside and outside relative humidity information, with 1% resolution. You might use the information to calculate the heat index, or to monitor conditions in a greenhouse.

Changes in barometric pressure are generally the most useful weather prediction indicators. A falling pressure trend usually means that stormy weather is on the way, while a rising trend portends sunshine. The weather station uses a solid-state pressure sensor to make accurate, stable, high-resolution barometric pressure measurements. Although not possible with the "freeware" program, a professional version of the software permits all weather data to be stored on your computer's hard disk. Graphing features make it easy to see and interpret pressure trends.

The signal-conditioning electronics for the temperature and humidity sensors can be wired point-to-point in the wiring grid area on the Experimenter board. With a tight layout, all of the components will fit on the board. However, be aware that every fourth pad on the top and bottom rows of the wiring grid are connected to +5 volts and ground, respectively. Those pads are convenient for supplying power to logic ICs, which have power and ground connections in the standard locations of upper right and lower left. But you must be careful to avoid inadvertent connections to +5 volts and ground when wiring other circuitry.

As an alternative to point-to-point wiring, you can make your own signal-conditioning board using the foil patterns provided here. A high-quality PC board is also available from the source given in the Parts List.

Signal-conditioning board

None of the meteorological sensors connect directly to the Experimenter. They all require some signal conditioning from the circuitry shown in Fig. 1. The op-amps, RC filters, and digital prescalers prepare the outputs of various sensors so that the Experimenter can measure them with maximum accuracy. If your Experimenter

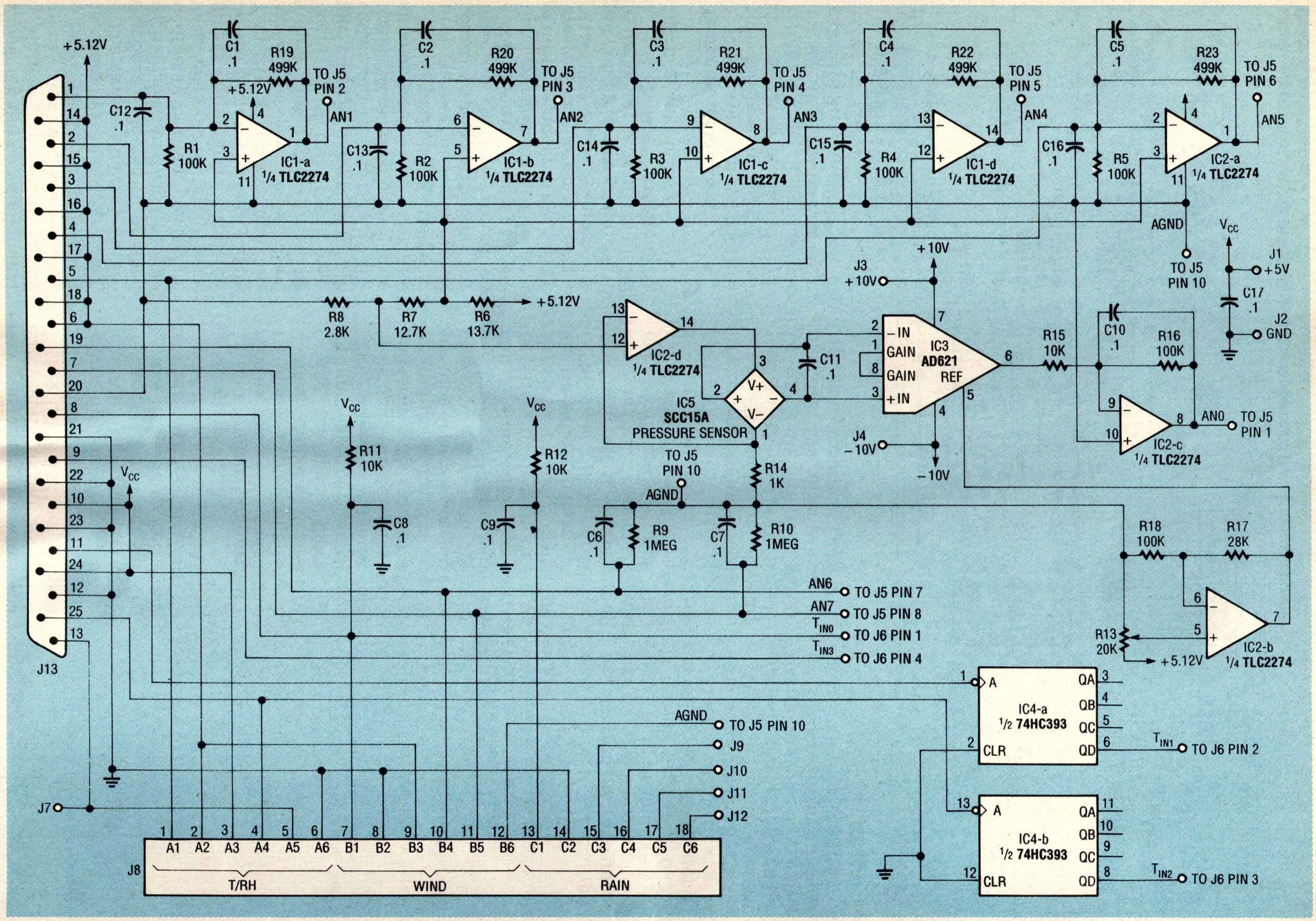

+5.12V
C1 .1
R19 499K
TO J5 PIN 2
AN1
IC1-a 1/4 TLC2274
R1 100K
C12 .1
C2 .1
R20 499K
TO J5 PIN 3
AN2
IC1-b 1/4 TLC2274
C13 .1
R2 100K
C3 .1
R21 499K
TO J5 PIN 4
AN3
IC1-c 1/4 TLC2274
C14 .1
R3 100K
C4 .1
R22 499K
TO J5 PIN 5
AN4
IC1-d 1/4 TLC2274
C15 .1
R4 100K
C5 .1
R23 499K
TO J5 PIN 6
AN5
IC2-a 1/4 TLC2274
C16 .1
R5 100K
AGND
TO J5 PIN 10
VCC
J1 +5V
C17 .1
J2 GND
R8 2.8K
R7 12.7K
R6 13.7K
IC2-d 1/4 TLC2274
J3 +10V
+10V
IC3 AD621
-IN
GAIN
GAIN
REF
+IN
C11 .1
IC5 SCC15A PRESSURE SENSOR
V+
V−
J4 −10V
−10V
R14 1K
R15 10K
C10 .1
R16 100K
IC2-c 1/4 TLC2274
AN0
TO J5 PIN 1
R11 10K
R12 10K
C8 .1
C9 .1
C6 .1
R9 1MEG
C7 .1
R10 1MEG
R18 100K
R17 28K
R13 20K
IC2-b 1/4 TLC2274
AN6 TO J5 PIN 7
AN7 TO J5 PIN 8
TIN0 TO J6 PIN 1
TIN3 TO J6 PIN 4
IC4-a 1/2 74HC393
A
CLR
QA QB QC QD
TIN1 TO J6 PIN 2
IC4-b 1/2 74HC393
TIN2 TO J6 PIN 3
AGND TO J5 PIN 10
J9
J10
J11
J12
J7
J13
J8
A1 A2 A3 A4 A5 A6 B1 B2 B3 B4 B5 B6 C1 C2 C3 C4 C5 C6
T/RH
WIND
RAIN

FIG. 1—SIGNAL-CONDITIONING BOARD. This circuitry conditions the signals obtained from the weather instruments before sending then to the Experimenter.

board does not have the analog supply option, you should add it. Many sensors use the analog inputs, and the optional analog supply will assure the highest accuracy in readings.

The through-hole plated circuit board from the kit supplier, with solder mask and component identification screened on both sides of the board, simplifies construction and improves circuit reliability. Figure 2 is the part-placement diagram. Be sure to clean all residual solder rosin from the board, which can provide leakage-current paths that will cause loss of accuracy in the temperature and pressure measurements.

Inputs and outputs that connect the signal conditioning board to the Experimenter are labeled on the board by silkscreening. These connections must be made to the pads of the same name on the Experimenter. Don't forget to wire the +10- and −10-volt supply inputs on the conditioning board to the power pads of IC5 pins 2 and 6 on the Experimenter board.

Temperature sensors

The weather station temperature sensors are LM334Z current sources. Because their output is current, rather than voltage, the sensors can be located 100 feet or more from the weather station without the series resistance of the wire leads affecting the reading.

Each LM334Z requires a 2.26-kilohm bias resistor for setting the nominal output current. A 0.01-microfarad capacitor across each sensor enhances its stability. Both components can be soldered directly across the leads of the LM334Z as shown in Fig. 3.

The completed temperature sensors should be sealed in a 1.2-inch long piece of 3/16-inch diameter dual-wall heat-shrink tubing. This special tubing has an inner layer of hot-melt gap-filling adhesive; when the tube is heated, the adhesive melts and forms a moisture-proof seal around the leads. If an end of the tube does not close up completely, use a pair of pliers to gently squeeze it shut while the glue is still liquid. Use only a hot-air gun or hair dryer to shrink the tubing, and don't allow the tubing to burn.

PART NUMBERS FOR SIGNAL-CONDITIONING BOARD

Resistors
R1–R5, R16, R18—100,000 ohms, 1%
R6—13,700 ohms, 1%
R7—12,700 ohms
R8—2870 ohms, 1%
R9, R10—1 megohm, 5%
R11, R12—10,000 ohms, 5%
R13—20,000 ohms, multiturn potentiometer
R14—1000 ohms, 1%
R15—10,000 ohms, 1%
R17—28,000 ohms, 1%
R19–R23—499,000 ohms, 1%
Capacitors
C1–C16—0.1 µF, ceramic
Semiconductors
IC1, IC2—TLC2274 op-amp (National Semiconductor) or equivalent
IC3—AD621 instrumentation amplifier (Analog Devices)
IC4—74HC393 dual counter (Harris) or equivalent
IC5—SCC15A solid-state pressure sensor (Sensym)
Other components
J13—Male DB25 connector
J14—Female DB25 connector
J8—Triple 6-contact modular phone jack

The male DB-25 connector, J13, on the signal-conditioning board makes it easy to connect remotely-mounted sensors. Figure 4 shows how the various sensors connect to J13. The positive leads of the temperature sensors connect—with appropriate lengths of wire—to pins 14–18 of J14, a female DB-25 connector that plugs into J13. The output leads of the temperature sensors connect to pins 1–5 of J13. You can also connect the leads from temperature sensor number 5 to pins 1 (output) and 2 (+V) of J8-a, one-third of a triple 6-contact modular jack. The modular jack is a more convenient way to connect outdoor sensors.

Once the temperature-sensor outputs reach the signal conditioning board, resistors R1–R5 convert the current outputs from the five sensors into

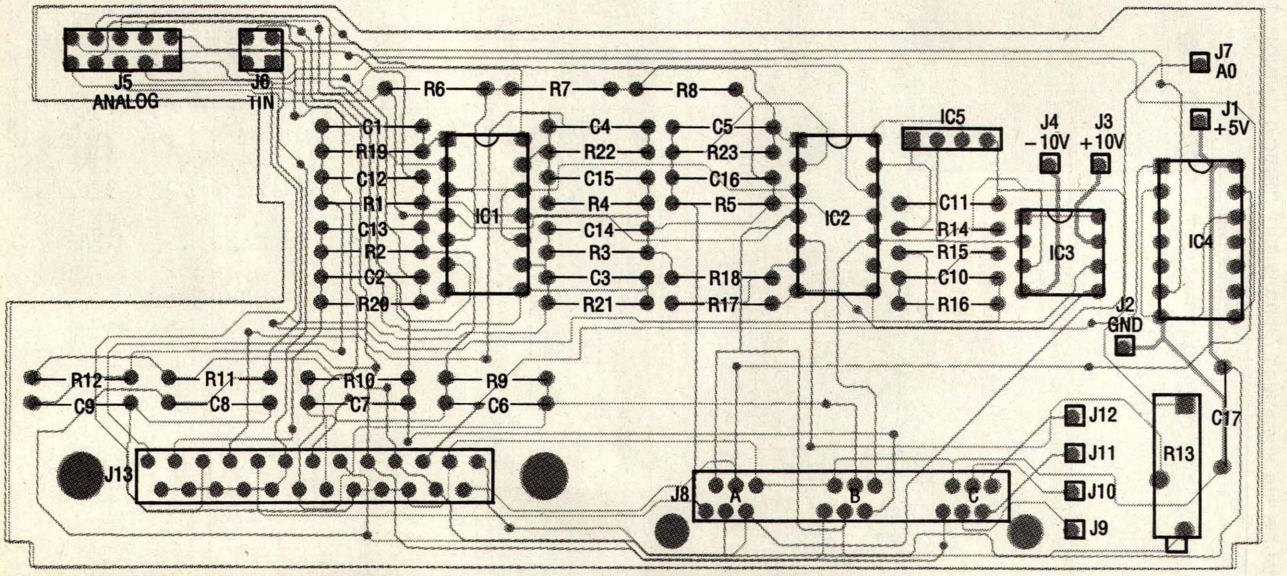


FIG. 2—PARTS PLACEMENT DIAGRAM. Position the parts on the signal-conditioning board as shown here.

PARTS AND KITS

The following kits are available from Fascinating Electronics, PO Box 126, Beaverton OR 97075-0126. You can call 1-800-683-KITS with VISA and Mastercard orders, catalog requests, and technical questions 24 hours a day, 7 days a week. Please include $3.40 for US shipping and handling with any order. Canadian shipping and handling is $5.00, with payment in US dollars. Foreign orders, please inquire for prices and availability. NOTE: The following kit descriptions are also to be used as parts lists. If you are gathering the parts together on your own, you'll need all parts listed under the "Complete Kit" headings to build each unit.

voltage outputs of about 10 millivolts per degree Kelvin (absolute). The voltage divider R6-R7-R8 provides a bias voltage to offset the temperature range from absolute zero to more common ranges. The TLC2274 op-amps IC1-a–IC1-d and IC2-a, along with R19–R23, provide a gain of 5, amplifying the temperature-sensor outputs to 50 millivolts per degree Celsius. Capacitors C1–C5 and C12–C16 provide low-pass filtering to remove electrical noise from the temperature readings.

Humidity sensors

Relative humidity is the ratio of the water vapor in the air to the maximum amount of water vapor that the air can hold at the ambient temperature and pressure. It is expressed as a percentage. The humidity sensors used here are capacitors whose values change in proportion to the humidity level. A timer circuit converts the capacitance value to a frequency that is prescaled and then measured by the Experimenter.

The circuit that converts the capacitance of the sensor into a frequency must be located very close to the sensor so that stray capacitance from long lead wires has no effect on humidity readings. However, once converted into a frequency, the signal can be sent over long wire runs back to the Experimenter without being affected.

As indicated in Fig. 4, humidity sensors 1 and 2 get power (+5 volts) from pins 10 and 24, respectively, of the DB-25 connector J13. Ground connections are provided on pins 23 and 12. Humidity inputs go to pins 11 and 25. The signal-conditioning board also provides connections for humidity sensor 2 on pins 3–6 of modular jack J8-a. That allows you to connect outdoor temperature and humidity sensors to the signal-conditioning board with a single 6-conductor phone cable and modular plug.

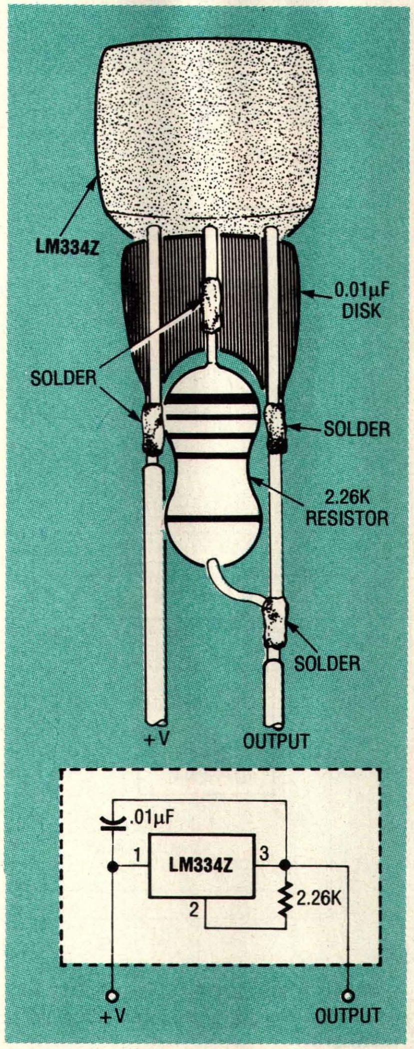


FIG. 3—TEMPERATURE SENSOR. The LM334Z is used as a current output temperature sensor. A 2.26-kilohm bias resistor and 0.01 µF capacitor are soldered directly to the leads of the device (see text).

Simple 555 timer circuits convert the capacitance of the humidity sensors to frequency. The frequency outputs then go to IC4, a 74HC393 dual divider located on the signal-conditioning board. The 74HC393 prescales the outputs (through a divide-by-16 operation), and sends the results to the timer inputs T_{IN1} and T_{IN2} on the Experimenter.

The circuit that does the frequency conversion can be wired directly on the 555 timer as shown in Fig. 5. Solder a 1 megohm, 1% resistor between pins 7 and 8 on the bottom of the 555 timer. Solder another 1 megohm, 1% resistor between pins 7 and 2, and continue the wire from pin 2 to pin 6. Solder a 0.1 microfarad disc capacitor between pins 1 and 8, and bend the capacitor over so that it rests on the top side of the 555.

If a humidity sensor and a temperature sensor will share a modular-plug connection to J8-a, the first two conductors in the cable are used by the temperature sensor, and the next four by the humidity sensor.

A humidity sensor's converted frequency output can interfere with the temperature signal if the two signals are conducted

ANEMOMETER

- **Complete kit—$37.50**

(3) 3-inch diameter plastic hemispheres, punched
(1) oil-impregnated bronze bearing, 0.126- × 0.252- × ⅜-inch, flanged
(1) stainless-steel shaft, 0.1247- × 3-inch, pointed on one end
(1) shaft lock, ⅛-inch
(1) magnetic switch, 1.5- × 5/16-inch, with hex nuts
(2) disk magnets, ½-inch diameter
(1) 2-inch schedule-40 PVC cap, precision drilled
(1) 1½-inch schedule-40 PVC cap, precision drilled
(1) 1½-inch schedule 40 PVC pipe, 5 inches long, drilled
(1) wood block, ¾- × 1½- × 1½-inches
(2) No. 4 stainless-steel sheet-metal screws, ½-inch long
(3) 8-32 stainless-steel machine screws, 4 inches long
(15) 8-32 stainless-steel hex nuts
(3) No. 8 stainless-steel flat washers
(18) No. 8 stainless-steel lockwashers, internal tooth
(1) No. 10 stainless-steel hex-head sheet-metal screw, ½-inch

Hard-to-find parts kit—$17.50

(3) 3-inch diameter plastic hemispheres, punched
(1) oil-impregnated bronze bearing, 0.126- × 0.252- × ⅜-inch, flanged
(1) stainless-steel shaft, 0.1247- × 3-inch, pointed on one end
(1) shaft lock, ⅛-inch
(1) magnetic switch, 1.5- × 5/16-inch, with hex nuts

WIND VANE

- **Complete kit—$39.90**

(1) dual-wiper potentiometer
(1) ball bearing, ¼-inch ID, ⅝-inch OD, flanged
(1) plastic spacer, ⅛-inch ID, ¼-inch OD
(1) tail fin, anodized aluminum, punched and folded
(1) potentiometer mounting bracket, punched and folded
(1) 1½-oz. lead egg-shaped fishing weight, drilled
(1) 2-inch schedule-40 PVC cap, precision drilled
(1) 1½-inch schedule-40 PVC cap, precision drilled
(1) 1½-inch schedule-40 PVC pipe, 5 inches long, drilled
(1) wood block, ¾- × 1½- × 2-inches, drilled
(1) hose, 1½ inches long, ⅛-inch ID
(3) 6-32 stainless-steel machine screws, 1-inch long
(3) 6-32 stainless-steel hex nuts with lockwashers
(6) No. 6 stainless-steel flat washers
(3) No. 6 stainless-steel lockwashers
(1) 8-32 stainless-steel machine screw, 2½ inches long
(2) 8-32 stainless-steel machine screws, ½ inch long
(6) 8-32 stainless-steel hex nuts
(2) 8-32 stainless-steel hex nuts with lockwasher
(6) No. 8 stainless-steel lockwashers
(2) 10-24 stainless-steel machine screws, 6 inches long
(7) 10-24 stainless-steel hex nuts
(2) No. 10 stainless-steel flat washers
(8) No. 10 stainless-steel lockwashers

- **Hard-to-find parts kit—$15.50**

(1) dual-wiper potentiometer
(1) ball bearing, ¼-inch ID, ⅝-inch OD, flanged

- **Assembled and tested anemometer & wind vane on "T" mount with 100 foot cable and modular connector—$159.90**

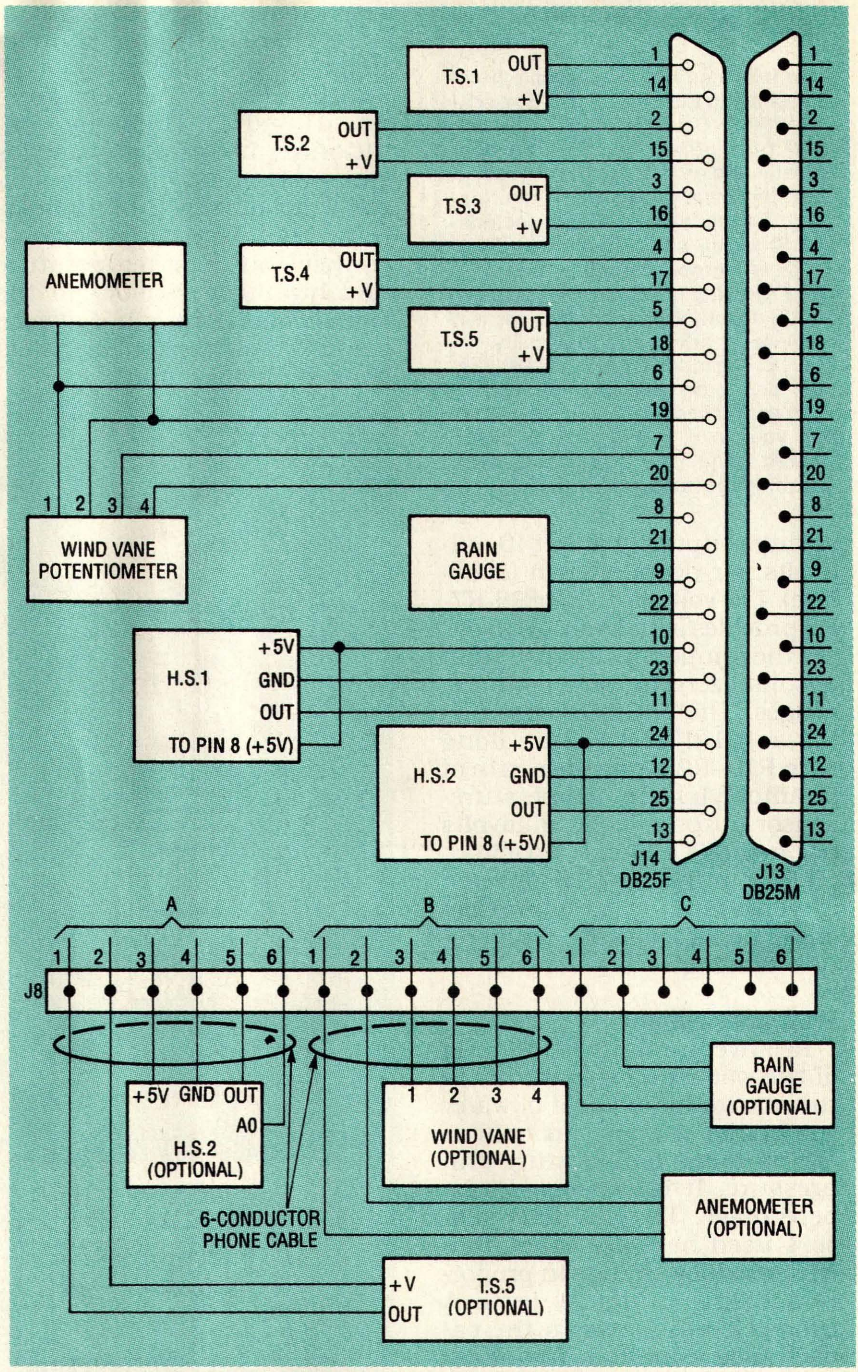

T.S.1
OUT
+V
T.S.2
T.S.3
T.S.4
T.S.5
ANEMOMETER
1 2 3 4
WIND VANE POTENTIOMETER
RAIN GAUGE
H.S.1
+5V
GND
OUT
TO PIN 8 (+5V)
H.S.2
1 14 2 15 3 16 4 17 5 18 6 19 7 20 8 21 9 22 10 23 11 24 12 25 13
J14 DB25F
J13 DB25M
A
B
C
1 2 3 4 5 6
J8
+5V GND OUT
AO
H.S.2 (OPTIONAL)
6-CONDUCTOR PHONE CABLE
WIND VANE (OPTIONAL)
RAIN GAUGE (OPTIONAL)
ANEMOMETER (OPTIONAL)
T.S.5 (OPTIONAL)

FIG. 4—A MALE DB-25 CONNECTOR (J13) and a triple 6-contact modular jack (J8), mounted on the signal-conditioning board, allow easy hookup of remotely located sensors.

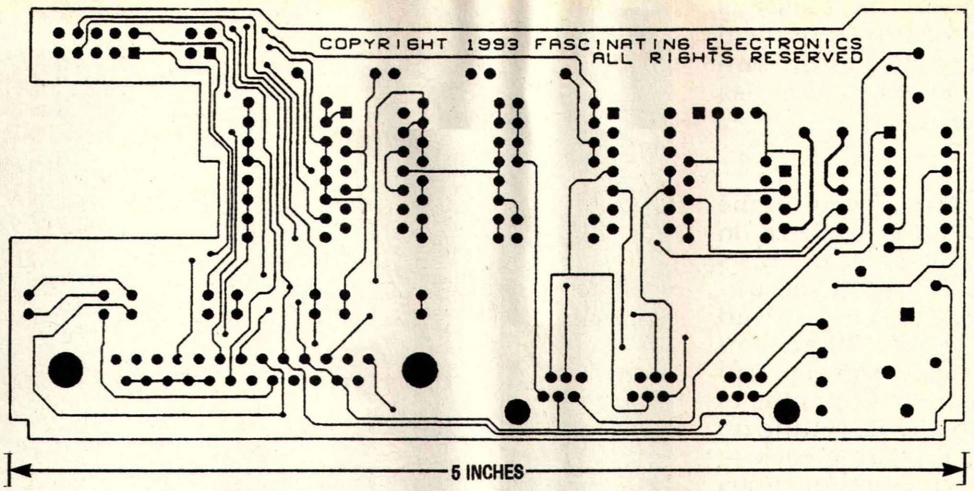
in the same cable. For that reason, digital output AO from the Experimenter can be used to turn the humidity sensor off when temperature readings are taken. The AO signal is routed to pin 13 of J13 and to pin 6 of J8-a, which lets the sixth wire in the telephone cable connect the AO line to pin 4 of the 555 assembly. If a humidity sensor does not share a cable with a temperature sensor, jumper pin 4 of the 555 assembly to the +5-volt supply at pin 8.

Attach three or four leads to the 555 timer assembly depending on whether or not it will be sharing a cable with a temperature sensor. (Remember to jumper pin 4 of the 555 to pin 8 if only three leads are to be used.) Use color-coded cabling or label the wires.

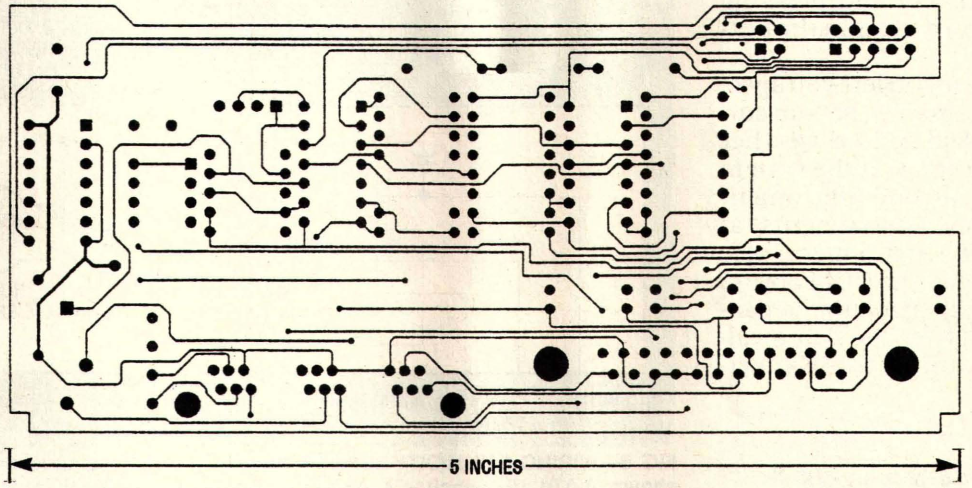
Slip a 1¼-inch long piece of ½-inch diameter dual-wall heat-shrink tubing over the 555 timer assembly, and then solder the humidity sensor to pins 6 and 8 of the 555. Its polarity is unimportant.

Use a hot-air gun to shrink the tubing over the 555 timer assembly. (Note that too much heat can damage 555.) Use pliers to gently squeeze the tubing closed as the hot-melt glue cools to seal both ends around the wires. Take care not to get the humidity sensor hot, as it can be damaged.

Now wire the three or four connections from the humidity sensor back to the signal-conditioning board as shown in Fig. 4.



WEATHER BOARD COMPONENT SIDE.



WEATHER BOARD SOLDER SIDE.

Barometer

Barometric pressure, caused by the atmosphere, constantly varies as high- and low-pressure systems circulate around the world. The first meteorologists used mercury barometers to measure barometric pressure. A mercury barometer has a column of mercury that rises and falls in accordance with the barometric pressure.

At sea level on a typical day, air pressure will support a column of mercury about 30 inches tall, abbreviated 30 in Hg. Pressure can increase to about 31 inches during fair weather, or decrease to 28 inches or lower during a storm. At higher elevations, normal pressures are lower; the normal barometric pressure at 5,000 feet above sea level is only about 25 in Hg.

RAIN GAUGE

- **Complete kit—$29.90**

(1) magnetic switch, 1.5- × 5⁄16-inch with hex nuts (Hamlin Mfg.)
(1) disk magnet, ½-inch diameter
(1) downspout adapter, 2- × 3- × 3-inches, drilled
(1) measuring spoon, Rubbermaid No. 2235 ½ TBSP, drilled
(1) plastic funnel, 8-inch diameter funnel (spout must be smaller than ½-inch in diameter)
(1) 3-inch diameter schedule-40 PVC pipe, 3 inches long, drilled
(1) brass rod, 1⁄32-inch diameter, 2.75 inches long
(2) No. 6 stainless-steel sheet-metal screws, ½-inch long
(2) cocktail straw sections, ¾-inch long

- **Hard-to-find parts kit—$5.90**

(1) magnetic switch, 1.5- × 5⁄16-inch with hex nuts (Hamlin Mfg.)

- **Assembled and tested rain gauge with 50-foot cable and modular plug—$59.90**

The weather station measures air pressure with a Sensym SCC15A resistive-bridge pressure sensor (IC5). Op-amp IC2-d drives a constant current of 0.5 milliamperes through the bridge. Instrumentation amplifier IC3, an Analog Devices AD621, amplifies the very small signal from the SCC15A by a factor of 100. The AD621 requires plus and minus 10-volt power supplies. Op-amp IC2-b, in conjunction with multiturn potentiometer R13, lets you compensate for pressure readings at your elevation. Op amp IC2-c amplifies the signal by 10, providing an output greater than 5 millivolts for each hundredth-of-an-inch of mercury. The pressure sensor can be seen in Fig. 6.

The SCC15A pressure sensor is sensitive to light. To prevent changes in ambient light from affecting pressure measurements, put a small cover of opaque black plastic (or paper) over the sensor. The sensor is also sensitive to mechanical stress, so do not bend the sensor leads after the sensor has been calibrated.

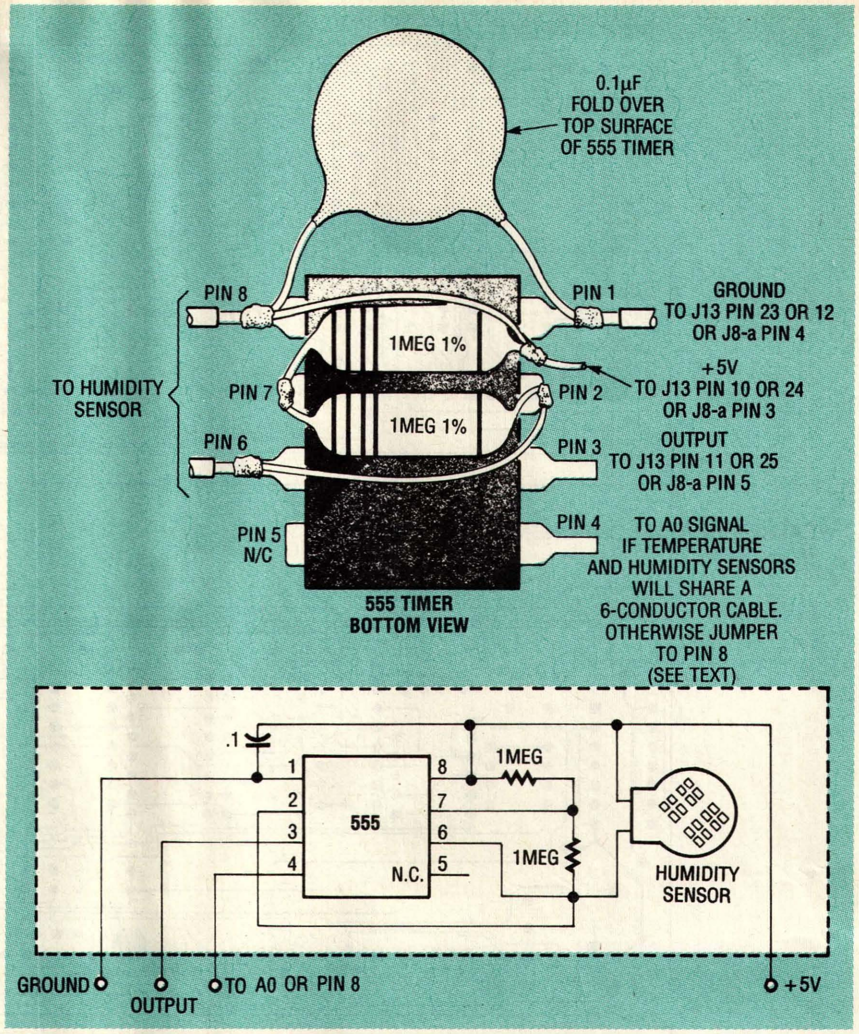

0.1µF
FOLD OVER
TOP SURFACE
OF 555 TIMER
PIN 8
PIN 1
GROUND
TO J13 PIN 23 OR 12
OR J8-a PIN 4
1MEG 1%
+5V
TO J13 PIN 10 OR 24
OR J8-a PIN 3
TO HUMIDITY
SENSOR
PIN 7
PIN 2
1MEG 1%
PIN 6
PIN 3
OUTPUT
TO J13 PIN 11 OR 25
OR J8-a PIN 5
PIN 5
N/C
PIN 4
TO A0 SIGNAL
IF TEMPERATURE
AND HUMIDITY SENSORS
WILL SHARE A
6-CONDUCTOR CABLE.
OTHERWISE JUMPER
TO PIN 8
(SEE TEXT)
555 TIMER
BOTTOM VIEW
.1
1
2
3
4
555
8
7
6
5
N.C.
1MEG
1MEG
HUMIDITY
SENSOR
GROUND
OUTPUT
TO A0 OR PIN 8
+5V

FIG. 5—WIRING A HUMIDITY SENSOR. Resistors are placed under the 555 timer IC as shown. A 0.01 µF capacitor is located on the top side of the timer (see text).

Software

The standard software for the weather station is available on the *Electronics Now BBS* (516-293-2283) as a self-unarchiving ZIP file called WEATHER.EXE. When you start the weather software you have the choice of beginning to take measurements, setting up the station, or exiting back to DOS. You can select functions by clicking on the function button with a mouse, or by holding down the Alt-key and pressing the highlighted letter in the button's name.

The setup menu lets you specify the instruments that are currently installed in your weather station. You can run the system with as few as one instrument and add new instruments at any time. The setup menu also lets you specify the COM port to which the Experimenter is connected. A setting is also available to simulate the Experimenter. Although this does not actually collect data, it's useful for demonstrating the software. Selecting the calibration function connects the computer to the Experimenter and brings up the calibration menu.

The calibration menu displays the present readings from all of the instruments. This is very useful for debugging purposes. The function buttons in the calibration menu allow you to enter new calibration values for each of the sensors. Exiting from the calibration menu returns you to the setup menu.

When you select "begin," the computer starts to collect and display data. If your computer has a display capable of EGA graphics or better, a graphical display of all measured values appears; if not, a text display is shown. The professional version of software begins collecting data and storing it on your computer's hard disk.

Pressing the space bar causes the program to leave the graphic display and present a menu. The professional version of the software provides you with selections for graphing stored data on-screen, or printing or plotting it. Data collection continues uninterrupted during these operations. You can also return to the calibration menu or DOS, but doing so will cause data collection to stop.

Calibration

All that's left to complete the weather station is the calibration of the weather instruments. Let's start with the anemometer.

- Anemometer. The anemometer's magnetic switch connects across pins 6 and 19 of the DB-25 connector J13. The

SENSORS

- **Temperature sensor kit—$15.90**

(5) LM334Z current sources (National Semiconductor)
(5) 2.26-kilohm, 1% resistors
(5) 0.01 µF capacitors
(1) dual-wall heat-shrink tube, 3/16-inch diameter, 6 inches long
(1) DB-25M connector, with shell

- **Humidity sensor kit—$29.90**

(2) humidity sensors (Philips 2322 691 9001)
(2) 555 timer ICs
(2) 0.1 µF disk capacitors
(4) 1-megohm, 1% resistors
(1) dual-wall heat-shrink tube, ½-inch diameter, 3 inches long

- **Assembled and tested temperature and humidity sensors—$99.90**

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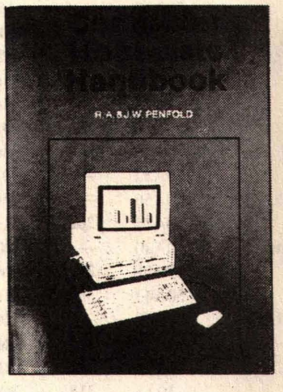
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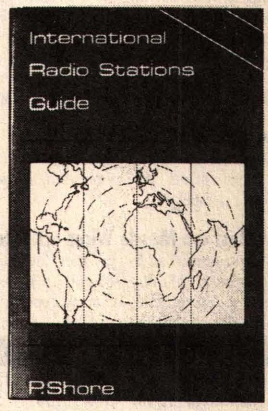
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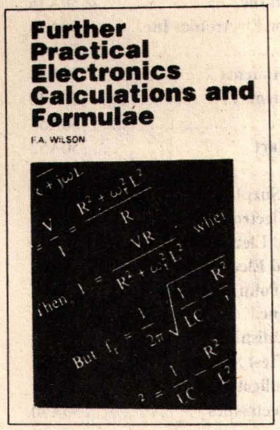
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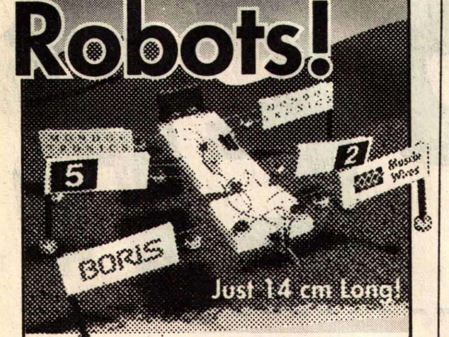

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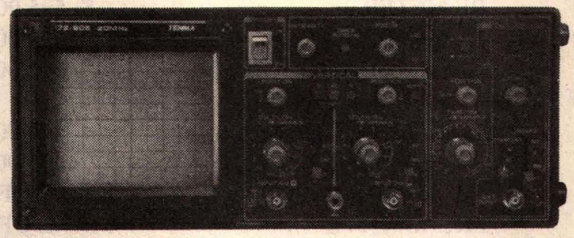
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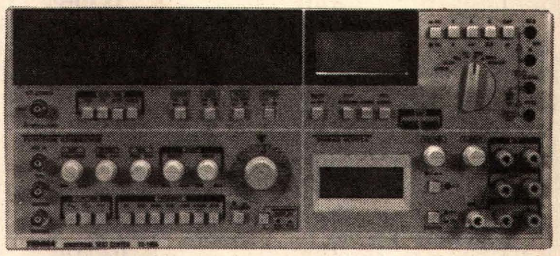

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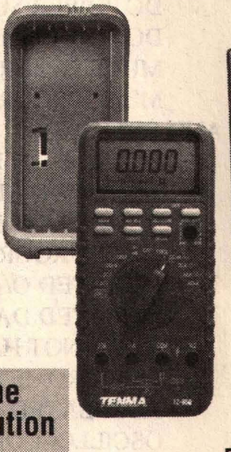

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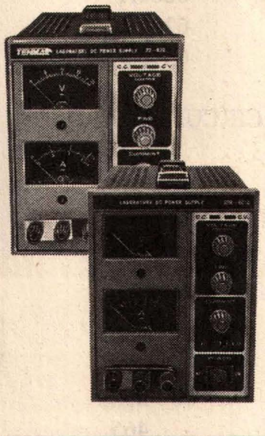
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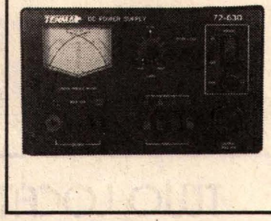
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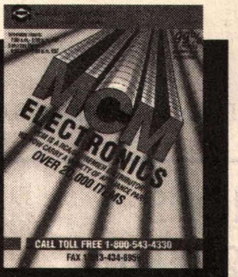
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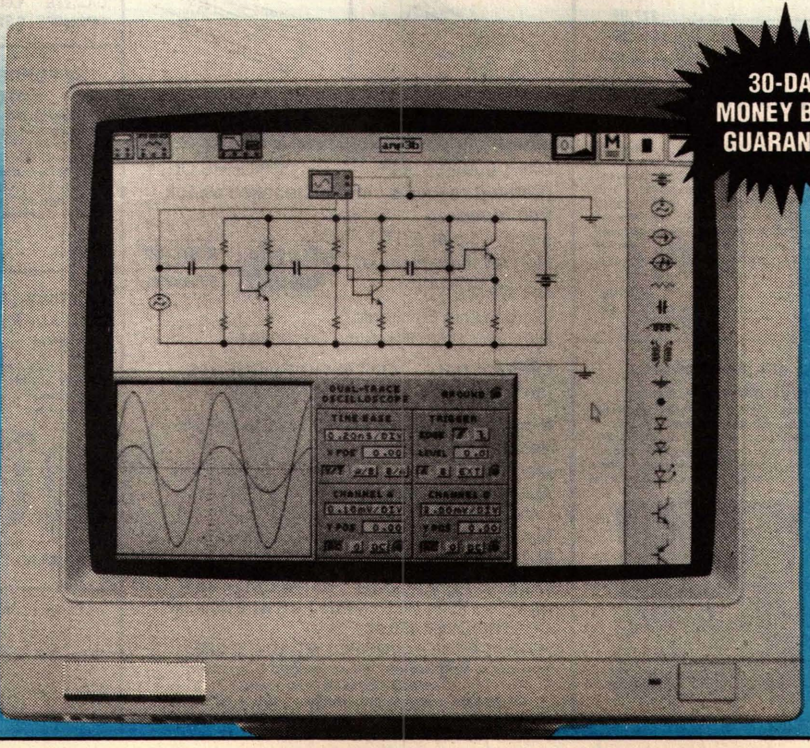

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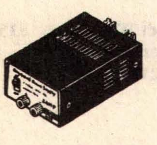

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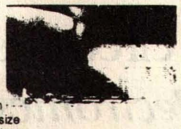

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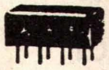

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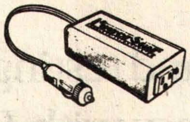

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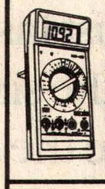

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...puts you in the pilots seat!!

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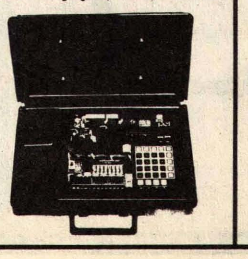

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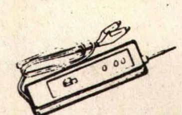

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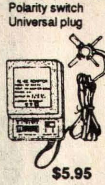

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1N5400	.20
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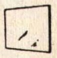

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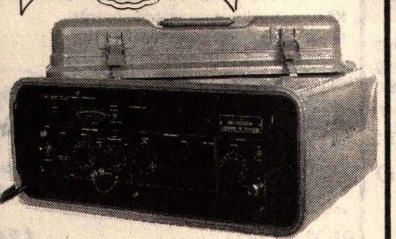

HEWLETT PACKARD 8640B-OPT 323 SOLID STATE SIGNAL GENERATOR

(w/o synchronizer) Frequency range: 450 KHz to 512 MHz, to 1100 Mhz with external frequency doubler option supplied. Ten Frequency bands in octave increments from 500 KHz; band 11 for doubler use. Accuracy: 6 digit LED read out. Stability: < 1000 ppm. Output power: −145 dBm to +10 dBm (0.013 V to 2 V) into 50 Ω. Impedance is 50 Ω, VSWR < 2.0 on 2 V and 1 V range <1.3 on other ranges >. Modulation: Internal AM, FM and PM, external AM, FM and PM. Pulse frequency: 0.05 to 5 kHz. General: Power Requirements: 100, 120, 220, 240 V, 48 hz to 420 hz, 2 amps. Size: 6" (H) × 19" (W) × 13¼" (D). Wt. 60 lbs. Includes ruggedized case and manual.

Price: $995.00

Current Hewlett Packard Prices: $12,050.00

TEKTRONIX 528 SOLID STATE N.T.S.C. WAVEFORM MONITOR

8 × 10 display, two composite video inputs
75 ohms, selectable 1 volt or 4 volt full scale,
(140 IRE units)
YRGB and RGB inpuy. Video output response
25Hz to 5 MHz ≤3%.
FOUR RESPONSE POSITIONS: 1] Flat, 2] IRE, 3] Chroma, 4] Differential gain.
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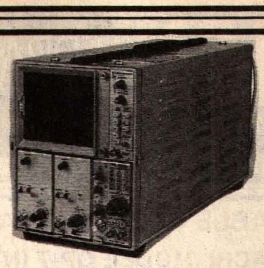
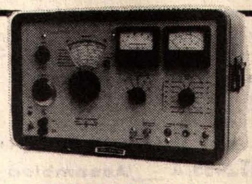
SIZE. 5'4"H × 8½"W × 18½"D
WEIGHT: 15 LBS
POWER: 115V 60 HZ 48 watts **Price: $495.00**



TEK MODEL 7603N

Oscilloscope: Mil Spec AN/USM-281C, 8 × 10 CM display, 100 mHz response which accepts standard 7000 series Plug-Ins. Vertical Plug-In: 2 ea. 7A15 (AM-6565), frequency BW 75 mHz, maximum sensitivity 5mV/DIV. Horizontal Plug-In: 1 ea. 7B53 (TD-1085), triggering to 100 mHz, minimum, sweep-time 50 NS/DIV, has delayed sweep capacity.

Includes cover probes accessories. **Price: $495.00**



HP MODEL 606B

Signal Generator: Later version of 606A. Frequency range of 50 KHz to 65 MHz in size bands; accuracy ±1%. Output level is continuously adjustable from 0.1uV to 3V into 50 resistive load. Modulation level of 0 to 95% on 1V attenuator range and below, 0 to at least 20% on 3V range **Price: $375.00**

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Frequency range: 2MHZ to 1000MHZ. **Power range:** 10 Watts to 1000 Watts. USWR≤ 1.08 to 1. Uses three plug-in coupler elements, (included). CU-753 2 to 30 MHZ 50 to 100 Watts·
CU-754 25 to 250 MHZ 10 to 500 Watts
CU-755 200 to 1000 MHZ 10 to 500 Watts
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Rack Mount Cabinets

MATERIALS

- Front/Rear/Display Panels: Aluminum
- Top/Bottom/Side Panels and Chassis: Steel

ATTENTION
Audio Buffs

These industry standard 19" rack mount cabinets are made from .04" steel, with the front and rear panels being made from .06" aluminum for easier, custom fitting. The display panel is .12" thick. These cabinets have been finished in gun metal grey and come flat packed, ready for your final construction. These enclosures have die punched venting. Handles are furnished on all cabinets except RC3120A. These are sturdy, well-made, commercial quality cabinets and are sure to make your project look its best.

Order Number	Retail 1-4	5-99	Front Panel	External Cabinet Dimensions (HxWxD)	Handle Height	Weight
RC3120A	37.90	34.90	19" x 1.6875"	1.5" x 16.625" x 9.625"	—	8 lbs.
RC3120B	45.90	43.90	19" x 3.4375"	3.25" x 16.625" x 9.625"	2.625"	9 lbs.
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RC3120D	57.50	53.50	19" x 5.1875"	5" x 16.625" x 13.1875"	4.25"	13 lbs.
RC3120E	62.50	59.50	19" x 5.1875"	5" x 16.625" x 16.75"	4.25"	15 lbs.

Ventilation Holes on Top, Bottom and Both Sides

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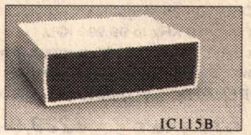
RC3120A

RC3120C

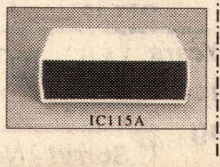
•Racks B, C, D and E feature extruded aluminum handles

Heavy Duty Instrument Cases

Perfect for communications equipment, power supplies, test equipment, computer switch boxes and more!!



IC115B



IC115A

FEATURES

- Both units split apart for ease of working
- Self-adhesive feet and screws included
- Plastic used for flexibility & strength
- Grey body complete with black front and rear panels
- IC115B includes ventilation slots and speaker recess

Order Number	Retail 1-4	5-99	Dimensions (HxWxD)	Approx. Weight
IC115A	7.95	6.95	2.5" x 8" x 6,4"	2 lbs.
IC115B	9.95	8.95	3.1" x 10" x 7.4"	3 lbs.

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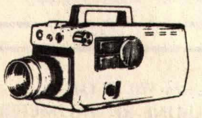
HITACHI MODEL GP-7 (NTSC)

High quality camera . . . ideal for studio, station, school, computer use with color frame grabber. Compatible with VCR's, color monitors, and with TV sets using an RF modulator. With color temperature adjustment, standard 1/4-20 tripod thread and carrying handle. **These cameras are removed from service, but fully checked before shipment. REQUIRES A STANDARD 1" C-MOUNT LENS WITH ADJUSTABLE IRIS.**



POWER REQUIRED: 12 VDC regulated. Total 8.6 Watts.
Use a power supply or rechargeable battery.

PICKUP TUBES:	3 Electrodes Vidicon HS-251 or equal
SCAN LINES:	525 Lines, 2:1 Interlace
SYNCH SYSTEM:	Internal or External
VIDEO OUTPUT:	1 V P-P into 75 Ohms, BNC Connector
RESOLUTION:	More than 250 Lines at Center
MIN SCENE ILLUM:	75 to 100 Lux with F1.4 to F2 lens
SIZE:	13.3" long x 5.6 wide x 5.75" high

RE92CTV2208 ______________ *$99.50*

CAMERA POWER SUPPLY - Hitachi Model AP6OU (CEK) AC Power Adapter, 115 VAC, 60 Hz input; 12 VDC, 2 A output.

RE93CTV2209 ______________ *$29.50*

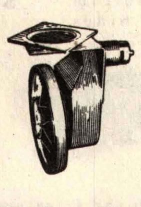
1" LENS - 25 mm f1.4 adjustable iris.

REG4-024 ______________ *$99.50*

RF Modulator - For color TV (requires 9-12VDC and some wiring/soldering)

RE89CMP5361 ______________ *$3.50*

MOTORIZED WHEEL ASSEMBLY



Ideal for Carts, Wagons, and ROBOTS. Will carry up to 100 lbs depending upon usage. A high quality reversible motor, driving a heavy duty gearbox with low speed and high torque. Wheel is 7" Dia with wide grooved rubber tire on high impact plastic frame. Top steerable, ball bearing mounting plate is 4" square with 4 mounting holes.

Speed of unit, from 3VDC thru 12VDC, will run from 40 thru 160 RPM. 5 to 7 Amps full load down to 1 Amp no load. O/A size 9H x 7W x 6-3/4" Dp.

RE92ROB2188 ______________ *$34.50*

BATTERY SPECIAL!

Gates 0840-0004 - rechargeable sealed Lead Acid cells. Six cells connected together for 12V at 12.5 Amp Hours. Features high charge/discharge rate, use in any position. Terminated with Wires. New. O/A size 6 x 4-1/4 x 5-1/2" High. Wt, 12lbs

RE93BAT2375 ______________ *$22.50*

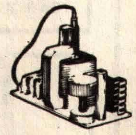
RUGGEDIZED HeNe LASER HEAD

APPROX 1.2 mW OUTPUT - BEAM VISIBLE BEYOND 300 FT

Class IIIA head used by military for weapons training/sighting contains high quality HeNe tube in stainless steel housing 1-3/4Dia x 14-1/4" long. Wavelength 632.8 nm. 8KV start, 1250 to 1400V operating at approx 5 mA. Built in ballast resistor.

RE92LSR2223 ______________ *$49.95*

POWER SUPPLY KIT FOR 1/2 TO 2 mW LASERS



INPUT - 12VDC 0.75 to 2 Amps depending upon tube power. Output voltages and current same as required in above laser head. Supplied with all parts and easy to follow assembly instructions. Circuit board size approx 5-1/2 x 2-1/4".

RE93KIT2459 ______________ *$39.95 KIT*

Kits not returnable once soldered

RE93KIT2459/A ___ Assembled ___ *$54.95*

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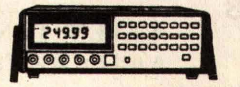

TRIPLETT MODEL 4800

Pushbutton control. Liquid crystal display. 16 functions: dbm, diode, relative set, data and peak hold, dual frequency input to 10 MHz period indication. An electronic comparator circuit for 'Go', 'High', 'Low', testing, temperature °C or °F using K type thermocouple (not supplied) and auto or manual ranging with basic DC voltage, accuracy of ±0.04%, continuity tone check. Operating voltage 117/230 VAC, 50/60 Hz.

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AC VOLTAGE:	True RMS 250 Millivolts - 750 Volts
DC CURRENT:	250 Microamps - 10 Amps
AC CURRENT:	True RMS, 250 Microamps - 10 A
RESISTANCE:	0 - 25 Megohms
FREQ TEST:	10 KHz to 99.999 KHz

Size 9-1/2 x 3-1/2 x 9-1/2". Supplied with instruction manual and test leads. New. 6 month factory warranty.

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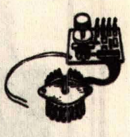
RET2-010___ QTY 1 to 9 ___ *$229.00 EA*
QTY 10 ___ *$199.00 EA*

STEPPER MOTOR CONTROLLER KIT

For 6 thru 30 VDC OPERATION



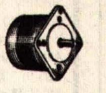
Kit contains all necessary components to construct this versatile device. Will operate 4 phase motors with current ratings up to 1.25 AMPS per phase continuous. Controls for direction, single step, hold, half-step, full-step and wave drive step sequences. Speed control from 1 to 1500 PPS. LED's indicate phase sequen Operate from a battery or power supply. Includes a 12V 7. motor for demonstration purposes.

RE93KIT2421 ______________ *$24.50 K*

Kits cannot be returned or exchange once they have been soldered

RE93KIT2421/A __ Assembled __ *$39.5*

STEPPER MOTORS



12VDC, 1.8 DEG; 6 LEAD
200 STEPS/REV
1/4 Dia X 3/4 Long Shaft

0.6 amps/ phase, 83 Oz-In holding torque, 2-1/4 Dia x 2-1/

RE93MTR2336 _____ NEW ______ *$19.5*

0.68 amps/ phase, 125 Oz-In holding torque, 2-1/4 Dia x

RE93MTR2337 _____ NEW ______ *$24.5*

STEPPING MOTOR DRIVER CHIP

Complete control and drive for a 4 phase unipolar steppi motor (6 or 8 lead motors). Can drive up to 35 V and 1. Amps per phase, continuous. Provides 3 different st sequences - wave drive, full step and half step. Built clamp diodes and thermal protection. Requires +5V chip. 16-pin in line DIP. New, supplied with data.

REQ5029 ______________ *$9.9*

NOTE: Chips cannot be returned once use

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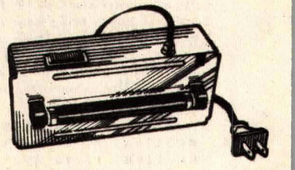
for 115 VAC operation, for the hobbyist and serious science experimenter.



Ideal for use by the amateur philateli archeologist, mineralogist, etc., for observi and investigating fluorescence in stamp minerals, etc. Fixture is equipped with F4T5BLB, 4 Watt filtered Blacklight bu operating in the range of 3100 to 40 Angstrom. Housed in an aluminum enclosure x 3 x 1-3/4", with key slots for mounting. Equipp with AC cord and plug, with on/off/push-to-st switch. New.

RE91UVL1699 ______________ *$19.5*

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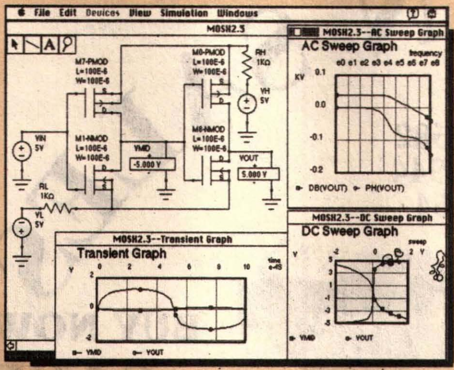
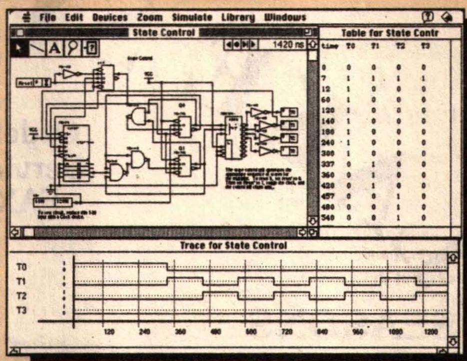

File Edit Devices View Simulation Windows
MOSH2.3
M7-PMOD L=100E-6 W=100E-6
M0-PMOD L=100E-6 W=100E-6
RH 1KΩ
VH 5V
VIN 5V
M1-NMOD L=100E-6 W=100E-6
VMD -5.000 V
M8-NMOD L=100E-6 W=100E-6
VOUT 5.000 V
RL 1KΩ
VL 5V
MOSH2.3--AC Sweep Graph
AC Sweep Graph
frequency
e0 e1 e2 e3 e4 e5 e6 e7 e8
KV
DB(VOUT)
PH(VOUT)
MOSH2.3--DC Sweep Graph
DC Sweep Graph
sweep
VMD
VOUT
MOSH2.3--Transient Graph
Transient Graph
time e-IS
YMD
YOUT

What is B² Logic 3.0?
B² Logic v.2.2 + EDIF File Format Output + Enhanced PLD Sim. Cap. + New Devices (inc. binary-to-seven segment decoder and one shot) + Print Across Mult. Pgs. + Subcircuit Probing + Table For Sim. Results + Model Primitives with User Def. Prop. + Mult. Document Interface in Microsoft Windows + Rotate Comp. + Check For Fan-Out Violations + More Accurate Power Calc. + Check For Max PulseWidth Violation + more!


File Edit Devices Zoom Simulate Library Windows
State Control
1420 ns
Table for State Contr
Trace for State Control
T0
T1
T2
T3
120
240
360
480
600
720
840
960
1080
1200

```
time  T0  T1  T2  T3
0     0   0   0   0
7     1   1   1   1
12    1   0   0   0
60    1   0   0   0
120   1   0   0   0
140   1   0   0   0
180   1   0   0   0
240   1   0   0   0
300   1   0   0   0
337   0   1   0   0
360   0   1   0   0
420   0   1   0   0
457   0   0   1   0
480   0   0   1   0
540   0   0   1   0
```

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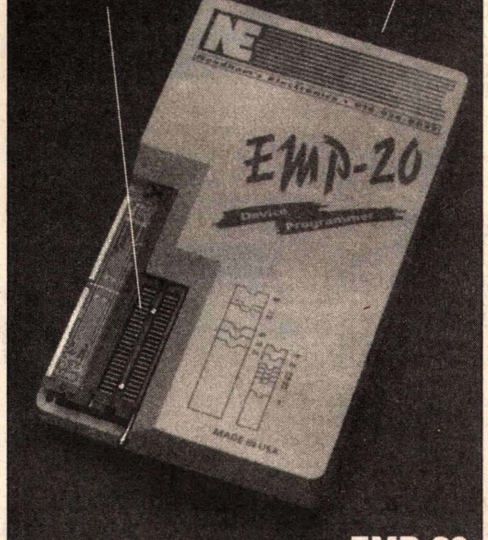
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EMP-20

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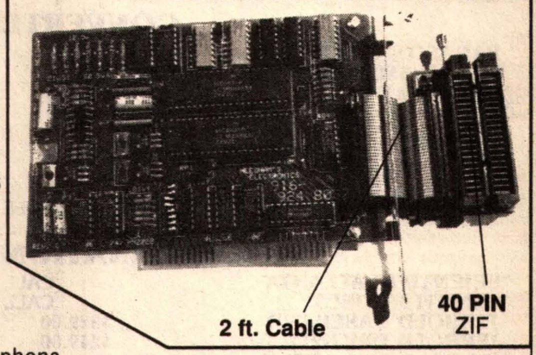

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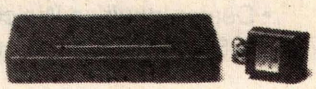

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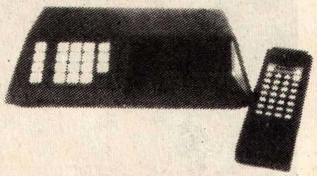

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- 2 ranges - 6 fast gate times
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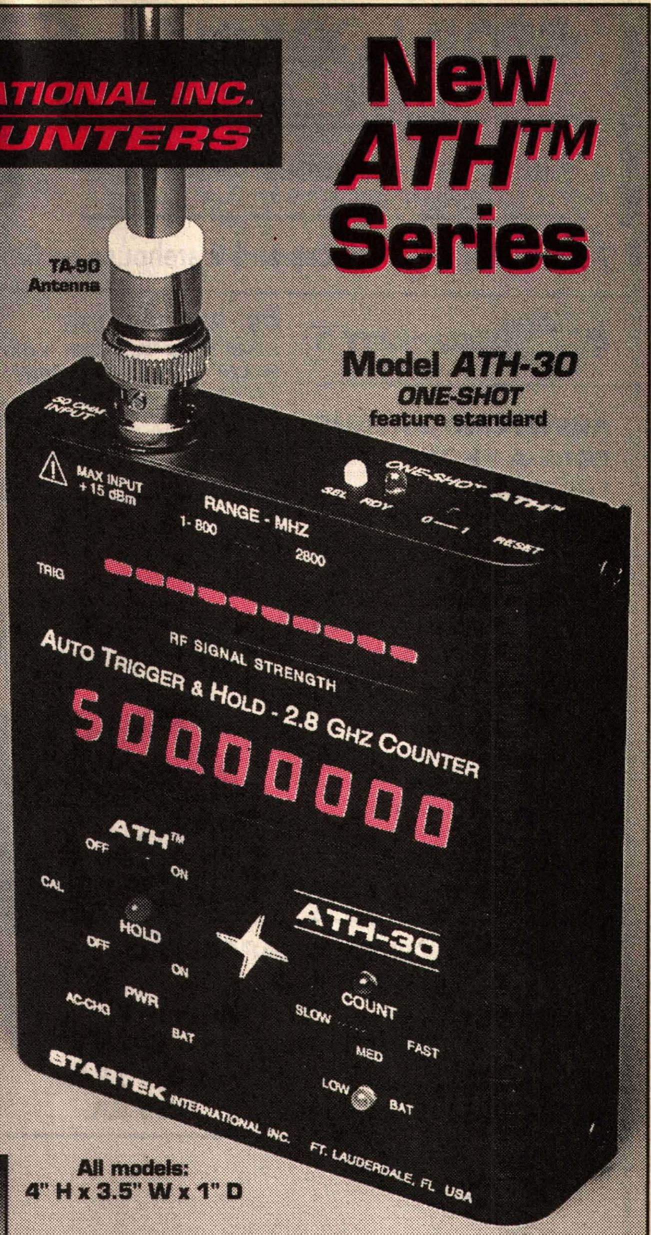
- ***StarCab™*** aluminum cabinet

TA-90
Antenna
15000000
ATH-15

Model *ATH-15*


TA-90
Antenna
50 OHM INPUT
MAX INPUT +15 dBm
RANGE - MHZ
1-800
2800
ONE-SHOT ATH™
SEL
RDY
0—1
RESET
TRIG
RF SIGNAL STRENGTH
AUTO TRIGGER & HOLD - 2.8 GHZ COUNTER
50000000
ATH™
OFF
ON
CAL
HOLD
OFF
ON
ATH-30
PWR
AC-CHG
BAT
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MED
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1350
3.5 GHZ FREQUENCY COUNTER
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3500
32000000
35-BG
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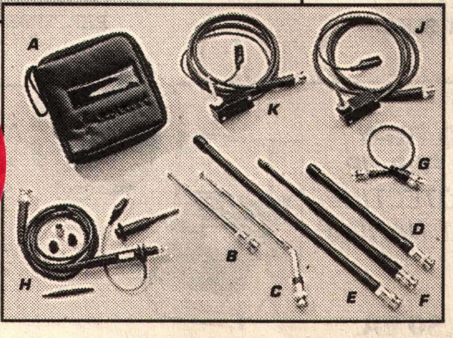
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15-BG	(not shown) 1-1500 MHZ Ultra high sensitivity, Bar Graph	*169*	~~220.~~
35-BG	1-3200 MHZ Ultra high sensitivity, Bar Graph	*249*	~~265.~~
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ATH-30	1-2800 MHZ, ***ATH, ONE-SHOT***	*259*	~~299.~~
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E ***RD-2750***	27-50 MHZ rubber duck		28.
F ***RD-800***	800 MHZ rubber duck		29.
G ***M-207-IC***	Interface cable for MFJ-207		10.
H ***P-110***	200 MHZ, 1x, 10x probe		39.
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VOLTAGE ADJUSTABLE. OUTPUT: + 5VOLT 200AMP FUSED. OVER VOLT & CURRENT PROTECTED. UL & CSA LISTED
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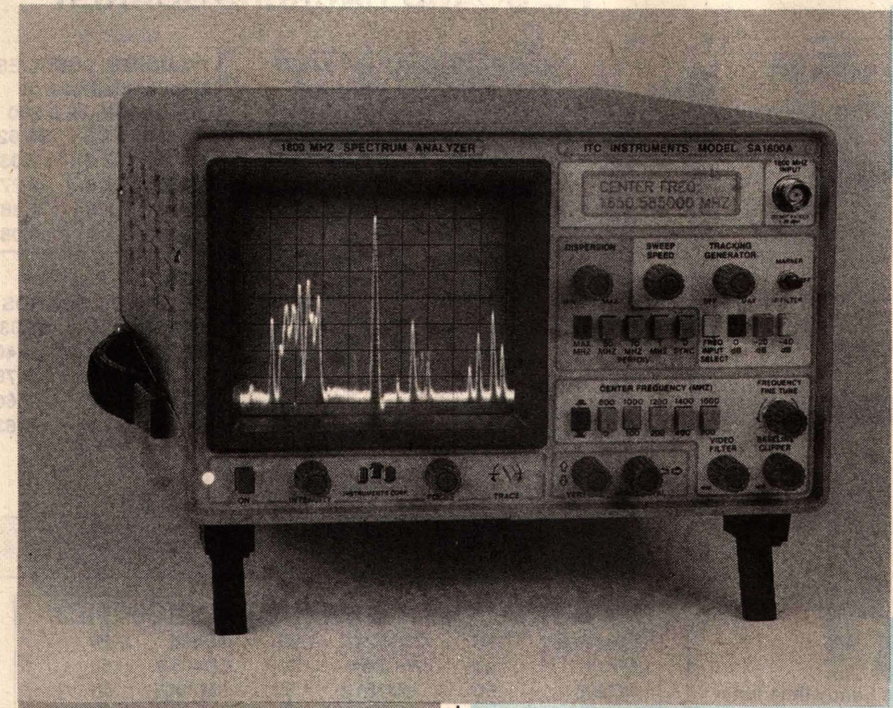

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SA1800A $1895.00
2mHz to 1800mHz

Opt. 1 50 mHz marker Generator
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Opt. 3 +/- 5 kHz Narrow Band Filter provides 5 kHz resolution BW
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Opt. 5 Tracking Generator Internal
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80 dB DYNAMIC RANGE ON SCREEN. ITC Exclusive EFPLA Log Amp. (pat. pending) Other low priced units only have 60 dB or 70 dB on screen.

-110 dB SENSITIVITY AT ALL SPAN WIDTHS. Only ITC provides -110 dBm .7 uv. sensitivity at wide & narrow span widths. Other low cost units provide 80 - 95 dB only at narrow Spans.

HIGH STABILITY Only ITC Analyzers provide high stability and low drift at any span. (I < then 1kHz per Hr. after warm-up)

EASY OF OPERATION: The SA Series controls are simple to understand and use, even if you never used a Spectrum Analyzer before you will be on line in no time.

FEATURES: Baseline Clipper, Video Filter, 5" CRT, 10 push-button Frequency select switches plus a 10 Turn Frequency control for 100 :1 tuning ratio. Providing easy frequency selection. The Dispersion is variable form 0 mHz to 50mHz per/div.

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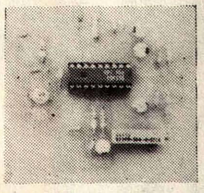
KIT CORNER

WIRELESS FM STEREO BROADCASTER KIT

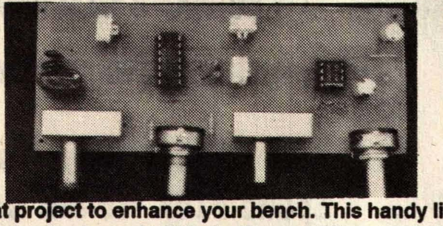
CAT. NO. SFM-II $19.95



DC'S all new FM Stereo Transmitter Kit is based upon the unique BA1404 Stereo Broadcaster Integrated Circuit that includes all the complex circuitry to generate the stereo signal. The kit includes the new special IC, a 38 KHz crystal, circuit board, and all the small components. This facinating project will provide many hours of enjoyment as you re-broadcast your CD/VCR/Cassette or stereo broadcasts from your satellite system thru your high-quality FM home or auto stereo system.

FUNCTION GENERATOR KIT ORDER FG2 KIT

$19.95



A great project to enhance your bench. This handy little function generator has a built-in buffer amplifier, a 3-decade range selector switch that covers 15 hZ to 25 khZ, output level control and function switch to select sine, square, or triangle.

ICL7106 EV KIT LCD DIGITAL PANEL METER NOW $24.95

The ICL7106 EV Kit is based upon a 3-1/2 digit A/D converter that includes all the circuitry to build a digital panel meter. Operates from a 9-v battery. Includes LCD, 7106 IC, circuit board and small parts. Builder must add resistors to expand to multi-meter

POWER SUPPLY KIT

PS-1 $16.99

Output of this power supply is continiously adjustable from 1.2 to 25V DC. The LM317T voltage regulator provides excellent regulation and ripple rejection. Includes a 1 A transformer, PC board, LM317T, 2 binding posts, and all small parts.

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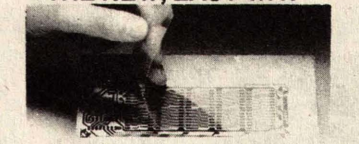
MAKE CIRCUIT BOARDS THE NEW, EASY WAY



WITH TEC-200 FILM
JUST 3 EASY STEPS

1. Copy circuit pattern on TEC-200 film using any plain paper copier.
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3. Peel off film and etch.

ORDER TEC-200-10 FOR TEN

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18 Uh CHOKE	.39	3.58 MHz	1.00		

ORDER ABOVE ITEMS DIRECT FROM THIS PAGE

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3 DIGIT LED DVM ONLY 3" X 3" READS 0 TO 100 V DC ORDER DVM3 $19.95

FM WIRELESS BROADCASTER	FMI	$ 9.95
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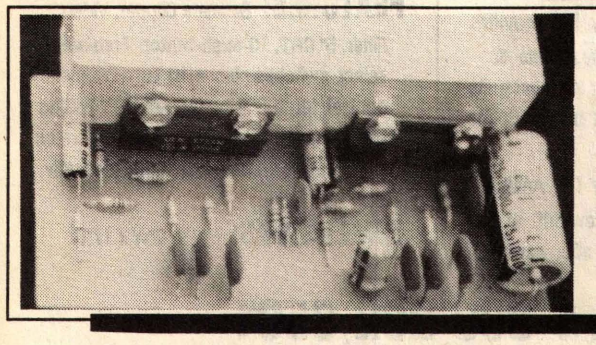
Build this unique seasonal project and have an unusual converstion piece. Powered by two D cells, 17 LEDs flash in a seemingly random fashon. Kit includes everything except batteries. ORDER XMASKIT $16.95



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MEMBER OF THE N.C.C.A.

Prices effective May 1, 1993. Prices subject to change without notice due to supply and demand.

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TOCOM 5507-VIP	$325.00	CALL	CALL
TOCOM 5503-VIP	$310.00	CALL	CALL
ZENITH 1600	$295.00	CALL	CALL
PIONEER 6110	$325.00	CALL	CALL
PIONEER 5135	$315.00	CALL	CALL
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JERROLD DPBB6	$250.00	CALL	CALL
JERROLD DPV-7	$225.00	CALL	CALL
JERROLD DPV-5	$195.00	$169.00	$165.00
JERROLD DRX-3-DIC	$ 95.00	$ 79.00	$ 69.00
HAMLIN CRX6600-3M	$ 90.00	CALL	CALL
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SCIENTIFIC ATLANTA 8590, 8580, 8536	CALL	CALL	CALL

All units come with new remotes.

CONVERTERS

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NEW	PANASONIC 1453G Parental Control, Sleep Timer, Remote Batteries	$67	$62	$59	$55
REFURB	JERROLD 400 Basic converter with new remote	$49	$40	$37	$32

ADD-ON DESCRAMBLERS

		1	5	10
NEW	MINI TVT-3G Nickname "1/4 Pounder"	$ 62.00	$ 52.00	$ 45.00
NEW	ORIGINAL TVT-G	$ 65.00	$ 50.00	$ 45.00
NEW	TBD-P	$ 90.00	$ 79.00	$ 72.00
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NEW	TNT Nickname "Star 7"	$115.00	$105.00	$ 99.00
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REFURB	MLD-1200-2 or 3	$ 48.00	$ 42.00	$ 35.00

MISCELLANEOUS

FREE Jumper Cables with all Combos. Remote Controls for most cable converters. Interference Filters sold to dealers only. Parental Filters to prevent children from viewing certain channels.

We are now offering a 6-month warranty. In order for warranty to be in effect, this form must be signed and returned.

FOR VCR, SECOND, THIRD, ETC. HOOK-UPS.

☐ Yes, I agree all units are to be used or resold in compliance with Federal and State laws.

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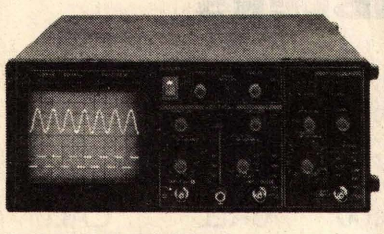


- ☐ Dual channel, 6" CRT.
- ☐ Sensitivity 5 mV/div to 20V/div.
- ☐ Vertical modes: CH1, CH2, dual, add, subtract.
- ☐ Time Base 20 steps from 0.2 μsec. plus X5 mag, X-Y, video sync.
- ☐ Two-year warranty.

P-3502 **$389.00**

Regulated DC Power Supply

- ☐ Output 0 - 30V, CV; 0 to 3A, CC.
- ☐ Two separate LED Displays (Green for voltage, Red for current).
- ☐ Short circuit overload protected with indicator LED.

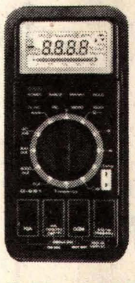
3003 **$249.00**

True RMS Expanded Function DMM

- ☐ 3-3/4 digit, 4000 count, with bar graph.
- ☐ Auto ranging, with optical data output of V-Ω-A-Hz-CAP.
- ☐ Has relative set, min/max, memory data & range hold, plus unique adapter mode.
- ☐ Supplied with protective holster/stand, deluxe safety probes.

D-937 **$139.00**

3-3/4 Digit "High Capability DMM"



- ☐ Extra Large LCD, 4000 count with Bar Graph.
- ☐ Fully auto ranging for AC/DC volts, resistance, temp, capacitance and frequency, plus range and data hold, relative, min/max and auto power off.
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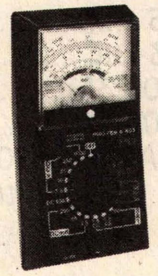
D-981 **$125.00**

"Super-Value" VOM



- ☐ 20 KΩ/V Sensitivity.
- ☐ Measures AC/DC volts, DC current to 10A, resistance, dB and battery test.
- ☐ Color coded meter scales, with anti-parallax miror.
- ☐ Overload protected by Silicon Double Diode and 2A/250V fuse.

A-403 **$19.00**

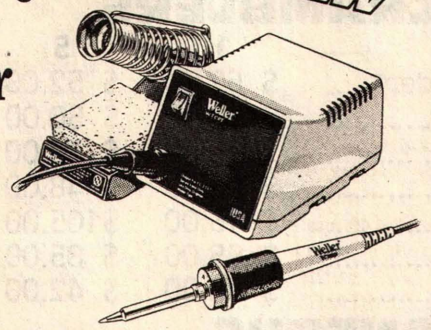
Controlled-Output Soldering Stations

NEW

Weller

WTCPT

$149.00



- ☐ Transformer powered soldering station complete w/lightweight, low voltage, temp. controlled soldering iron
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NEW SB-3 PAN	60.00	55.00
DPV-7212	CALL	MIKE
DPBB-7212	CALL	MIKE
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NEW HAMLIN MLD-1200	50.00	45.00
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Price effective 1/1/93 (Subject to change without notice)

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NEW ORIG. BA-6100 PAN	CALL	MIKE
SCIENTIFIC ATLANTA	1-3	4 or more
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8580:	250.00	CALL
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PANASONIC-VIEWSTAR	20 LOT	100 LOT
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ZENITH: Z-TAK	220.00	CALL
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* All Combos come with new Panasonic or Viewstar converter.
(Parental lockout units: No extra charge.)
Volume control units available

MOST ORDERS SHIPPED SAME DAY!

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SUB TOTAL
SHIPPING Add $4.00 per unit
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TOTAL

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☐ Yes, I am paying for full service. This is only to be used as a second unit.

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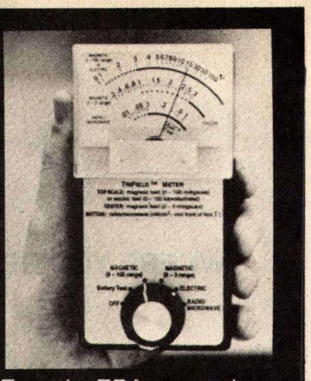

Most homes and offices have hot spots with strong artificial electro-magnetic fields, where chronic exposure may cause mental or physical problems. Even the EPA names these fields as suspected carcinogens. You can reduce your risk by avoiding these high-field areas.

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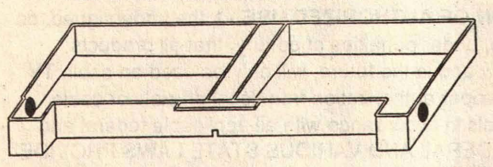

VT-103 $9.95

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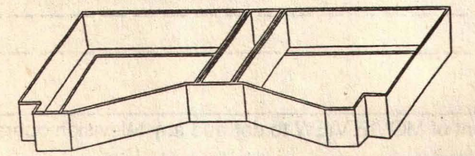

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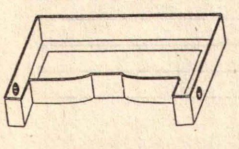

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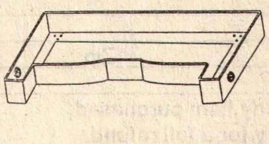

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(see page 9 of our up-dated ILLUSTRATED & COPYRIGHTED instruction manual)

INSTRUCTION MANUAL

HOW TO:

* Clean Video Heads	pg 3
* Check tape end sensors	pg 5
* Renew drive wheels	pg 4
* Adjust loading posts	pg 7
* Renew pinch roller	pg 6
* Clean erase & audio heads	pg 7
* Check Spindle sensors	pg 8
* Adjust tape guides	pg 9
* Adjust Tracking head	pg 7
* USE IN "G" CHASSIS	pg 9
* PLUS MANY TIME SAVING TIPS	

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1.0	35	.18 ea.
2.2	35	.17 ea.
3.3	20	.17 ea.
4.7	35	.24 ea.
6.8	35	.38 ea.
10	16	.28 ea.
10	25	.35 ea.
10	35	.45 ea.
15	16	.25 ea.
22	10	.20 ea.
22	16	.32 ea.
22	25	.45 ea.
33	16	.30 ea.
47	10	.38 ea.
68	6.3	.50 ea.
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Minimum 10 Pieces Per Type

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Shaft size: D .3"x1"L
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50 W Zenith Switching POWER SUPPLY

Input: 115/230 VAC 50-60 Hz
Output: 5 VDC @ 3A, +12 VDC @ 2A
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UL/CSA, L 6 1/4" x W 4" x H 2"
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Input: 120VAC/60Hz
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Standard Jumbo 5MM or 3MM

Red	**$.06 ea.**	20 piece
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* Table Top Model/2 Secondaries

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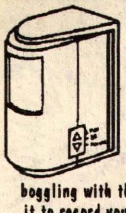

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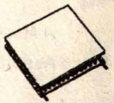
Drive bits with hollowed tips designed for those security screws often found in computers and other modern equipment. This set includes 9 different sizes of Torx bits (TT-7 thru TT-40), 4 sizes of square drive bits (S0 thru S3), 7 different sizes of hex bits (from 5/64 to 1/4), as well as flat and phillips bits, a socket holder, a 1/4" adapter, and a magnetic tipped handle to accomodate all the bits in the set. Handle also has a storage compartnent for pocket use, and the complete set comes in a sturdy plastic storage case. Ideal for the bench or toolbox.



SO COOL IT'S HOT!

127 THERMOCOUPLES PELTIER JUNCTIONS

Can coolers, coffee warmers, mini-refrigerators, and aquarium coolers are just a few ideas folks have come up with. Big or small, this little wonder is any hobbyist or experimenter's dream come true!!

The peltier junction is a solid-state thermovoltaic device. Current applied to the device will produce heat on one side of the device and a cold surface on the other side. **Water placed on the surface will freeze or boil depending on polarity of applied voltage.** Ideal for applications from 3-12 VDC -- whip out a battery and let your imagination run wild! Can be mounted in parallel to increase the "hot" or "cold" effect or they can be stacked in multi-stage cascades to achieve high differential temperatures. DOCUMENTATION INCLUDED!!!

Small Peltier Junction	(approximately 1.17" x 1.17" x .12")	**$20.00**
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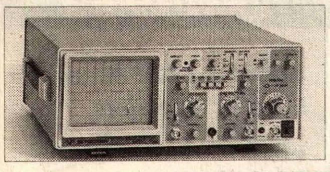

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20MHz Scope
Dual Trace

Reg. $549

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27512/C512, 27513*/C011*
27C010, 27C1001 (1 MEG)
27C020, 27C2001 (2 MEG)
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40 PIN EPROMS*1,2&4 MEG
27C1024, 27C2048, 27C4096
27C210, 27C220, 27C240
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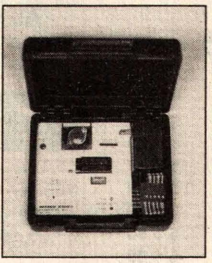

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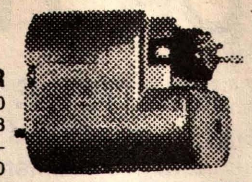
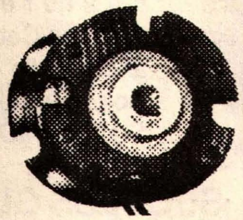


12 VDC, 70-110 mA, 10 RPM, 28 oz./in. torque, operating range 4-30 VDC. Measures approx. 1.5" x 1.5" x 1.25". Output shaft is 1/8" x 7/16". (93M003)

$7.95 each

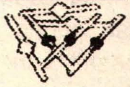
MOTOR BRAKE ASSEMBLY



24V @ 250 mA nominal. 0.375" shaft. OD: approx. 2.375". Height: 1.1875". Mounting: four holes on 2" diameter circle. Disengages when energized.

(93M004) **$5.95 each**

SCHOTTKY "HOT CARRIER" DIODE



V_{BR} 3.2V. V_F 250 mV @ 1 mA C_{JO} 0.1 pF nom. @ 0 V. R_D 12Ω typ. Usable to 20 GHz. Ideal for microwave mixers and other applications. Metelics #M2X1168. (93S018)

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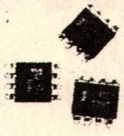
SURFACE MOUNT Dual Wideband JFET Op Amp



LF412. (93I012)

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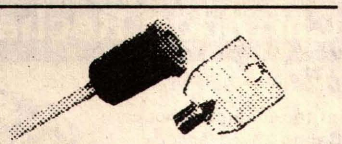
Other Surface Mount in Stock! Call or Fax for Stock Check.



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For cabinet doors. 1" long x 7/8" dia. cylinder with 5/16" x 1 1/2" threaded shaft with mounting hardware. P/N E3-56-715-50. (93Z020) **$9.95 each**

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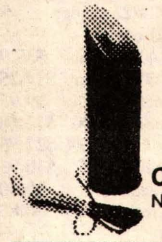

CLEAN AIR MACHINE

Negative ion generator. New.

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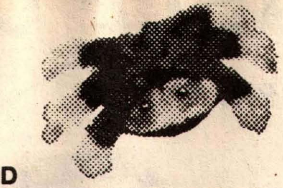

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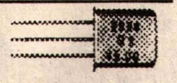

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1000PF ± 20%
5KV X5U 915

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815
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1226 MHz. Matsushita P/N GPS1226. (93P014)

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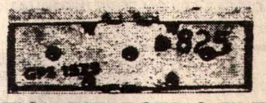

3-SECTION DIELECTRIC FILTER

1875 MHz. Matsushita P/N GPS1575. (93P013)

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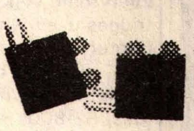

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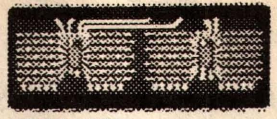

HDSP-2451

QDSP-2009

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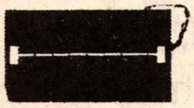

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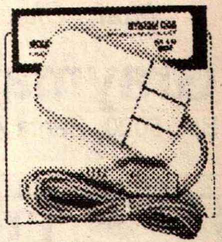
400 DPI MOUSE



Microsoft and Mouse Systems compatible for IBM/compatible systems. Dynamic resolution and fast tracking speed at 400 DPI. Opto-mechanical encoder. Model #G25200000-C.

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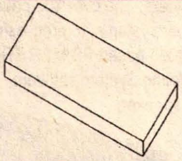

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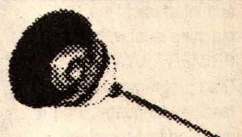

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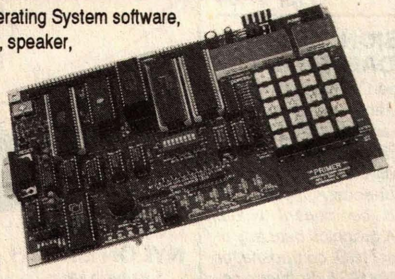
No other training system we know of comes close to matching the PRIMER's features at this low price. The PRIMER teaches more and is easier to use than other comparably priced trainers. The over 100 page Self Instruction manual takes you from binary number systems, to processing interrupts, to interfacing temperature sensors. The 8085 based PRIMER TRAINER comes complete with Monitor Operating System software, digital I/O, A/D, D/A, timer, speaker, display and keypad. Learn how to program and interface at the machine level with the PRIMER TRAINER. Start programming with machine language, then move on to Assembler, and then continue on with multi-tasking BASIC or Forth compilers. Ideally suited for beginners as well as advanced high-level programmers and engineers.



THE PRIMER IS $99.95 QUANTITY 10 OR ONLY $119.95 QUANTITY 1 IN KIT FORM. THE PRIMER ASSEMBLED & TESTED BY EMAC IS $169.95. ORDER NOW AND RECEIVE A FREE POWER SUPPLY. PLEASE ADD $5.00 FOR SHIPPING.

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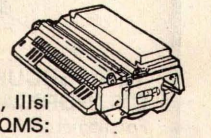
Toner Cartridge Recharge

Kits—Supplies—Service



Everything you need to recharge toner cartridges used with Canon based laser printers and personal copiers.
Use with HP: LaserJet, II, IID, IIP, III, IIIP, IIIsi
Apple: LaserWriter, LaserWriter IINT,IINTX, QMS:
Kiss, PS-800, PS-810, Canon: LB-P8A1,A2,II, OKI, NEC, Ricoh, etc
With our ***Kits—Supplies—Service*** you can start your own profitable recharge business or just recharge your own cartridges.

Model	Recharge Kits/Supplies	Retail Dealers Please Call
TR-300	Recharge Kit for CX type laser printer engines.	**$21.95**
TR-302	Recharge Kit for SX type laser printer engines.	**$26.30**
TR-304	Recharge Kit for HP IIP (LPB-4) laser printer.	**$21.95**
TR-325	Recharge Kit for PC-10/12/14/20/24/25 copier.	**$25.50**
TR-370	Recharge Kit for Sharp Z-50/55/70 copier.	**$34.95**
4080	Replacement Toner Kit for Ricoh 4080 laser.	**$35.95ea/5**
6000	Replacement Toner Kit for Ricoh 6000 laser.	**$14.25ea/10**
9710	200 grms of high quality black toner for CX.	**$9.95ea/10**
9730	250 grms of high quality black toner for SX.	**$12.50ea/10**
8011-Blue/Br	200 grms of Blue/Brown toner for CX & SX.	**$22.95ea/10**
8057	150 grms of high quality black toner for PC.	**$10.95ea/10**
Felt-CX,SX	replacement treated felt for all models.	**$0.90ea/10**
SS-CX,SX	seal strips for sealing in toner for reshipping	**$0.85ea/10**
DPP	Drum Padding Powder (pixie dust)	**$12.95**
EverDrum™	OPC drum life extender agent. 40+ applications	**$34.95**
C2094	3M Toner Vacuum with attachments.	**$199.95**

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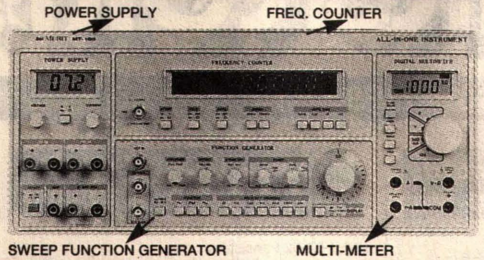


MT-100

Reg. $595.

$399.00

Four Instruments in One Instrument

1 Function Generator
- Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
- 0.02 Hz ~ 2MHz

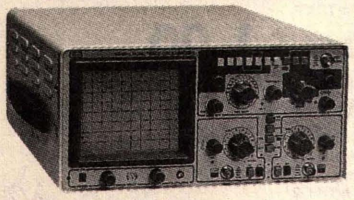
2 Frequency Counter
- 8 Digit LED
- 1 Hz ~ 100MHz
- ± (1 Hz + 1 dgt. + Time Base Error)

3 Power Supply
- 3-1/2 Digit LCD
- Triple output: #1. 0~50V, 0.5A MAX #2, 15V, 1A #3. 5V, 2A

4 Digital Multimeter
- 3-1/2 Digit LCD
- DCV, ACV, Ω, DCA, ACA
- ± (0.5% + 2 dgts)

BEST BUY! O'SCOPES

2 Yr. Parts/Labor Warranty



25 MHz Dual
Reg. $525.
$299.00

25 MHz Dual
w/Component Test
Reg. $595.
$379.00

40 MHz
Dual/Delay
Reg. $695.
$499.00

OS-3304/3324, 25 MHz
- DC to 25 MHz. Dual Channel
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 20V/div X-Y modes, Z Axis (intensity modulation)
- Rise time 14n Sec. or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 2kV

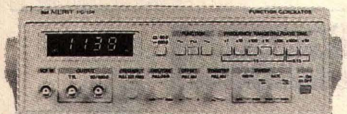
OS-3315, 40 MHz Sweep Delay
- DC to 40 MHz. Dual Channel
- Delayed Sweep 100nS to 1 Sec.
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 20V/div X-Y modes, Z Axis (intensity modulation)
- Rise time 8.5nS or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 12kV

GoldStar Oscilloscopes
OS-7020A. 20MHz Dual
Reg. $525. **$395.00**
OS-902RB. 20MHz Dual/Read Out
Reg. $795. **$595.00**
OS-9040D. 40MHz Delay
Reg. $695. **$575.00**
OS-904RD. 40MHz Dual/Read Out
Reg. $895. **$695.00**
OS-8100. 100MHz 8 Trace
Reg. $1,395. **$1,145.00**
Other Models *Call for Price*

FG-150

Reg. $395. **$229.00**

2MHz Sweep / Function Generator w/Built-in Frequency Counter



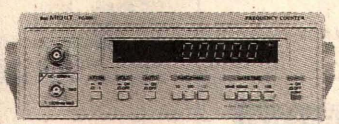
- 4 Digit LED Display
- 0.2 Hz ~ 2.0 MHz
- Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
- Linear or Logarithmic Sweep
- Variable DC Offset Control
- 10 MHz Frequency Counter

Best Buy!

1.0 GHz Counter FC-200

Reg. $395. **$199.00**

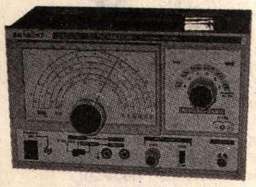
High Resolution Frequency Counter



- 1.0 Hz ~ 1.0 GHz
- 8 Digit LED Display
- Auto & Manual Range
- Measured Value Hold
- 4 Selectable Gate Times
- Below 20mV Input Sensitivity
- 1mΩ & 50Ω Input Impedance
- 10:1 Input Switchable Attenuator

Reg. $199. **$119.00**

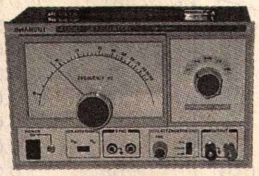
RF Signal Generator, SG-310 100KHz - 150MHz



- 100KHz ~ 150MHz, 6 Ranges.
- Accuracy : ± 5%
- RF Output: 100 m Vrms (Up to 35MHz Unloaded)
- Modulation
  Int. 1KHz (AM) 30%
  Ext. 50Hz ~ 20KHz
- Audio Output: 1KHz Min 2 Vrms

Reg. $199. **$119.00**

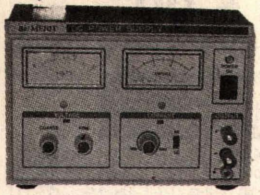
Audio Generator, AG-350 10Hz ~ 1MHz



- 10Hz ~ 1MHz, 5 Ranges.
- Accuracy : 5% ± 2
- Output Inpedance : 600Ω
- Sine Wave Output
  - Range : 10Hz ~ 1MHz
  - Output Voltage : 8 Vrms
- Square Wave Output
  - Range : 10HZ ~ 100KHz
  - Output Voltage : 15Vp-p

Reg. $249. **$159.00**

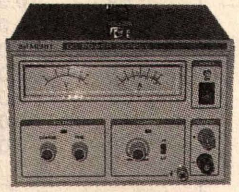
DC Power Supply, PS-500 0-30VDC, 0-3A



- 0 ~ 30VDC Continuously Variable
  - Regulation : ≦ 0.01% + 3mV
  - Ripple Voltage : p-p ≦ 2m Vrms; ≦ 1mV
- 0.1A ~ 3A Constant Current
  - Regulation : ≦ 0.2% + 3mA
  - Ripple Current : ≦ 3m Arms
- Short Circuit Overload Protection w/Indicating Lamp

Reg. $399. **$289.00**

DC Power Supply, PS-540 0-16VDC, 0-10A



- 0 ~ 16VDC Continuously Variable
  - Regulation : ≦ 0.01% + 3mV
  - Ripple Voltage : p-p ≦ 2m Vrms; ≦ 1mV
- 0.1A ~ 10A Constant Current
  - Regulation : ≦ 0.2% + 3mA
  - Ripple Current : ≦ 3m Arms
- Short Circuit Overload Protection w/Indicating Lamp

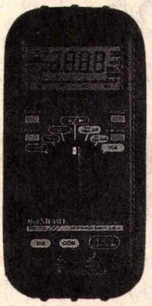
Oscilloscope Probes Switch Selectable X1 / X10

HP-9060, 60MHz
Reg. $29. **$15.00**

HP-9150, 150MHz
Reg. $49. **$22.00**

HP-9250, 250MHz
Reg. $59. **$29.00**

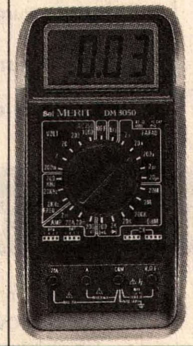
Auto Bargraph w/Holster



DM3200
Reg. $99.
$59.00

- Auto & Manual
- 3-1/2 Digit
- 32 Seg. Bargraph
- Diode Test
- Continuity Beeper
- Data Hold
- Auto Power Off
- Low Battery Mark
- Over Range Mark
- Holster

Multimeter Multi-Function w/Holster



DM3000
Reg. $69.
$44.00

DM3050
Reg. $99.
$54.00

DM3100
Reg. $99.
$54.00

- 3-1/2 Digit
- 1.5" Big LCD
- Heavy Duty, 20A
- Capacitance
- TR-hFE
- Diode
- Low Battery Mark
- Over Range Mark
- Protective Holster
- Tilt Stand

DM3050 Only
- Frequency
- Continuity Beeper

DM3100 Only
- Temperature w/ Optional Probe
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- Continuity Beeper

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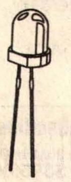
JUMBO LED'S

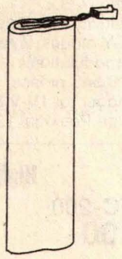


Big, bright 10 mm dia. LED's will attract attention in any display or panel. Twice the dia. of regular LED's, stand about 10 mm above panel.

RED MAXI LED **CAT# LED-22R**
GREEN MAXI LED **CAT# LED-22G**

3 for $1.00

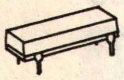
4 (USED) AA RECHARGEABLE BATTERIES



Battery pack with 4 AA nickel-cad batteries in series to make a 4.8 volt pack. Batteries have solder tabs and can be separated and reconfigured.

$ 2.00 per pack CAT# NCB-41AAU

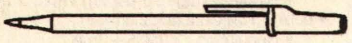
SOLID STATE DIP RELAY



International Rectifier # DP61K "Chipswitch" SPST normally open solid state relay in DIP configuration.
AC Load: 300 ma., 20-280 Vac
DC Input (turn on): 5 to 25 ma.
The DC input can be any voltage as long as the current is maintained between 5 and 25ma. Use a dropping resistor to do this. LARGE QUANTITIES!!!!

CAT# SSRLY-03 **$ 1.50 each**
25 for $31.25

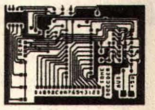
UV "INVISIBLE" INK PEN



When the ink dries the writing of these felt tip pens is visible only under a UV "black light". Originally for marking personal belongings in case of theft, these pens might also be used for writing secret messages or marking merchandise for inventory control.

3 for $ 1.00
100 for $ 25.00 CAT# UVP

Make PC Boards in Minutes...

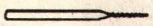


Prototypers, developers and hobbyists can now make PC boards direct from CAD, PCB layout systems or magazines using a photocopier, or laser printer. Techniks Inc's new "Press-n-Peel" copy paper allows you to photocopy PC artwork and iron it onto copper-clad board. It can then be chemically etched in the usual fashion. The process is so easy and fast you won't believe it. CAT# TEK-5

Five 8 1/2" X 11" sheets and instructions.

$ 9.95 per pack

CARBIDE DRILL BITS (USED)



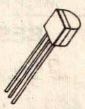
High quality, solid carbide drill bits with 1/8" shanks. Ideal for precision drilling.
These bits were used in PC board manufacturing and were routinely removed from service while they still had lots of life in them. Available in the following sizes:

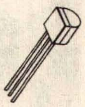
#	SIZE (")	CAT#
81	0.013	DRB-81
78	0.016	DRB-78
73	0.024	DRB-73
71	0.026	DRB-71
68	0.031	DRB-68
67	0.032	DRB-67
66	0.033	DRB-66
65	0.035	DRB-65
63	0.037	DRB-63
61	0.039	DRB-61
59	0.041	DRB-59
58	0.043	DRB-58
57	0.045	DRB-57
56	0.046	DRB-56
55	0.052	DRB-55
54	0.055	DRB-54
49	0.073	DRB-49

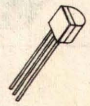
Minimum Purchase 10 Pieces Of One Size

10 of one size $ 5.00
50 of one size $ 20.00

TRANSISTORS Special Purchase Large Quantities







NPN, TO-92 transistors.
Two types available:

SAMSUNG # KSR1009 (R1009902).
Same as 2N3706, 2N3708 or 2N3711.
Crosses to ECG 85/289A or NTE 85/199.
CAT # TRX-1

12 for $ 1.00
100 for $ 5.00 (5¢ each)
1000 for $ 30.00 (3¢ each)

NATIONAL House numbered part # 136207C0058 Same as MPSH11.
Crosses to ECG or NTE 229.
CAT # TRX-2

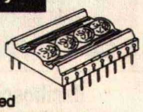
12 for $ 1.00
100 for $ 5.00 (5¢ each)
1500 for $ 45.00 (3¢ each)

VIDEO/RF MODULATOR

Originally made for use with the Commodore computer, these good quality video modulators were probably originally designed for 9 Vdc use, but they operate well on 6-12 Vdc. They accept color video and audio, and a selector switch is provided for output to channel 3 or 4. Easy to hook-up. Requires a 6-12 Vdc power supply or wall transformer and a connector to interface with your audio/video source. Output is an RCA jack. Hook-up instructions included. 3" X 1.47" X 0.75".
CAT# AVMOD-3

$ 5.00 each

4 Digit Alphanumeric Intelligent Display



Siemens # DL-2416T.
End-stackable, four digit display module with built-in CMOS memory decoder/driver.
High contrast, 0.160"high magnified red characters. Direct access to each digit independently and asynchronously. ASCII format. 5 volt logic, TTL compatible. Module size: 1" X 0.8" X 0.25"
Includes specs and instructions. Sells elsewhere for as much as $19.95.

CAT# DL-2416T **$ 4.95 each**

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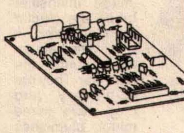


With a minimum of external wiring, this PC board will control the speed and duration of a 120 Vac motor or other load up to 300 watts. When activated, motor will operate for 10, 20 or 40 minutes or continuously at high, medium or low speed. To simplify hook-up we recommend using our membrane keypad, CAT# KPM-12 ($1.25 each) which, with slight modification works with this device. Instructions included.

$ 3.00 each

CAT # MSC-5

PLOTTER PENS

TEXAS INSTRUMENTS
TI-1 Style Plotter Pens

TI-1 style plotter pens.
Assorted colors.
5 pens per pack.

For use on the following plotters:
Hewlett-Packard (all), Houston Instruments (695A & Image Maker), Roland DG(DXY-101, DXY-800), Enter (Sweet P600), IBM (all), and many other compatible plotters.

Two styles, paper and transparency, are interchangeable. Paper inks are lighter than transparency inks.

BLACK,	transparency, 0.3 mm tip	**CAT# TR-3BK**
BLACK,	transparency, 0.7 mm tip	**CAT# TR-7BK**
GREEN,	paper, 0.7 mm tip	**CAT# PA-7G**
GREEN,	transparency, 0.3 mm tip	**CAT# TR-3G**
GREEN,	transparency, 0.7 mm tip	**CAT# TR-7G**
BLUE,	paper, 0.3 mm tip	**CAT# PA-3B**
BLUE,	paper, 0.7 mm tip	**CAT# PA-7B**
BLUE,	transparency, 0.3 mm tip	**CAT# TR-3B**
BLUE,	transparency, 0.7 mm tip	**CAT# TR-7B**
RED,	paper, 0.3 mm tip	**CAT# PA-3R**
RED,	paper, 0.7 mm tip	**CAT# PA-7R**
RED,	transparency, 0.3 mm tip	**CAT# TR-3R**
RED,	transparency, 0.7 mm tip	**CAT# TR-7R**

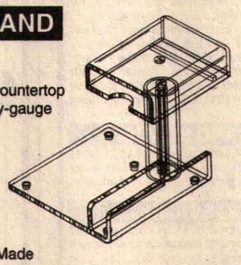
ASSORTED 5 DIFFERENT COLORS

ASSORTED,	paper, 0.3 mm tip	**CAT# PA-3A**
ASSORTED,	paper, 0.7 mm tip	**CAT# PA-7A**
ASSORTED,	transparency, 0.3 mm tip	**CAT# TR-3A**
ASSORTED,	transparency, 0.7 mm tip	**CAT# TR-7A**

All Plotter Pens Are In Packs Of Five

$ 2.00 per pack

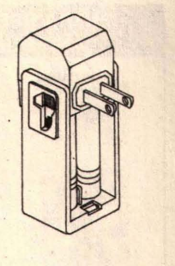
ACRYLIC STAND



Organize your desk or countertop with this attractive heavy-gauge acrylic stand originally designed for Verifone transaction microcomputer and printer. Makes a nice desk stand for all kinds of equipment, monitors, phones or calculators. Made entirely of crystal clear acrylic except for the metal rod that holds the top and bottom together, the unit consists of a 0.375" thick X 10.81" X 9.75" base. The top assembly is a cubbyhole made of 0.25" thick 10.25" X 8.31" acrylic. A 2.25" diameter X 6.31" long acrylic tube connects the two pieces. Requires assembly. Weight: 5 lbs, 10 oz.

CAT # PLEX-1 **$ 6.00 each**

AA NICKEL CADMIUM BATTERY CHARGER

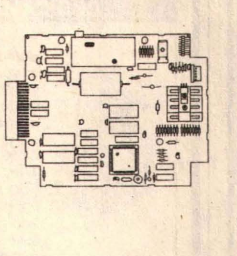


SANYO# NC-452
Battery charger for 2 or 4 AA nickel cadmium rechargeable batteries. Plugs into wall outlet and charges batteries in 8 to 10 hours. Can be folded for easy carrying and storage. 3.25" X 1.6" X 1.81" when folded. UL listed.

$ 2.50 each

CAT# AAC-1

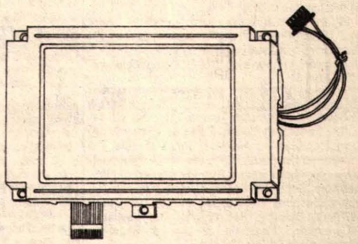
PC BOARD with RF MODULATOR (and lots of other parts)



PC board which contains among other things, a RF modulator. With a little desoldering you should be able to liberate a working unit from this board. Also contains 7805T voltage regulator with a couple of heatsinks, 20 assorted ICs, capacitors, resistors, diodes and connectors. No hook-up information available on the modulator.

$ 1.50 each **CAT# VMB-1**

LCD GRAPHIC DISPLAY 640 X 480 DOT MATRIX



Sharp # LM641481 Originally designed for Compaq Laptop Computers, this back-lit monochrome 640 X 480 dot matrix display has been upgraded with a 0.048" thick anti-reflection coated glass panel which reduces reflected light and makes the unit more scratch resistant. The overall viewing area is 6.25" X 8". Built-in high-speed LCD drivers (SED1600F). Interface through flexible 14 conductor ribbon cable.
Logic supply voltage: 5 Vdc.
LCD drive voltage: -16.5 Vdc.
Spec. and hook-up diagrams included. **CAT # LCD-11**

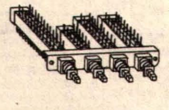
Original value OVER $ 300.00.

$ 35.00 each

MULTI-SWITCH ASSEMBLIES

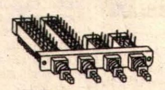
BLOW-OUT SPECIAL!!!!

Multi-pushbutton switch assemblies. Non-interlocking, switches work independently. All switches have solder loop terminals on one side and pc pins the other. Assemblies have mounting holes on 2.86"



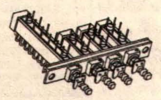
1 - 4PDT, 2 - 6PDT, 1 - 8PDT switches.
CAT# NISW-7

50 ¢ each



2 - 2PDT, 2 - 6PDT switches.
CAT# NISW-8

50 ¢ each



3 - 2PDT, 1 - 4PDT switches.
CAT# NISW-10

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***All software supports all IBM-PC compatible systems (8086 - 80486)**

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Van Eck Systems, Automated Tempest Module, KX Radar Emitter, Carjacking Foiler, Personal Body Alarm, Voice Disguiser, Hearing Assistor, Shriek Module, EM Countermeasure, Omnimax TENS, 6th Sense Communicator, many nifty **Phone Boxes, Bumper Beeper, Subliminal Mixer/Amp, Super MWO, Rife Device, Neurophone, Hieronymus Machine, MU Magnetometer, Data Card Reader/Writers, Dwelling Security System, Levitator, Vortex Generator, Ultrasonic Jammer & Receiver, Stealth Paint** - more! See our **Catalog.**

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We design, build, repair, modify, maintain and-or consult on any device, system, process or project - electrical, electronic, computer, phone, mechanical, optical, automotive. Invention prototyping. Confidentiality guaranteed. Describe and include $25 pre-engineering fee (does not obligate you). Time and cost estimates in 7-10 days.

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How cellular phones are designed, operated, re-programmed. How cellular systems are vulnerable to hack attacks, and countermeasures. Comprehensively describes modifying NAMs and ESNs (includes specific info. on 30+ popular models), scanning, scanner restorations (includes UHF TV method), freq and channel allocations, roaming, tracking, ECPA - more! **$39.**

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How **Voice Mail Box** (VMB) systems are used and the specific ways they are hacked. Includes **ASPEN, MESSAGE CENTER, BIX, GENESIS, EZ, SYDNEY, PHONE MAIL, AUDIX, CINDY, CENTAGRAM, SPERRY LINK, RSVP,** etc. Absolutely required for all users and sysops! **$29**

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TROJAN HORSES, VIRUSES, WORMS, etc. and countermeasures. Includes disk with 360K of hacker text files and utilities, and legendary **FLUSHOT+** protection system **(Ed. Choice, PC Magazine).** Dozens of computer crime and abuse methods and countermeasures. How systems are penetrated. BBS advice, password defeats, glossary - much more! **Manuals + Disks* $39.**

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As reported on **CBS "60 MINUTES": How certain devices can slow down - even stop - watthour meters - while loads draw full power!** Device simply plugs into one outlet and normal loads into other outlets. Also describes meter creep, overload droop, etc. Plans **$29.** THE I.G. MANUAL: External magnetic ways (applied to the meter itself) to slow down and stop watthour meters while drawing full loads. Plans. **$19.** KW-HR METERS: How watthour meters work, calibration, error modes (many), ANSI Standards, etc. **Demand and Polyphase Meters.** Experimental results to slow and stop meters by others. **$19.** Any 2, **$38.** All 3, **$59.**

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ATM crimes, abuses, vulnerabilities and defeats exposed! 100+ methods detailed, include: Physical, Reg. E, cipher, PIN compromise, card counterfeiting, magnetic stripe, false front, TEMPEST, Van Eck, tapping, spoofing, inside job, super-cool, vibration, pulse, high voltage - others. Case histories, law, countermeasures, detailed security checklist, labeled internal photos, figures. ATMs contain up to $250,000 in cash! Recent $350,000 ATM crime spree still unsolved! **$39.**

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How to design and build solid-propellant amateur and survival rockets. Emphasis on formulation, manufacture, installation of propellants, motors, igniters, etc. Includes list of commonly available materials, and the design of launch pads and test beds and their electronics. **$29.**

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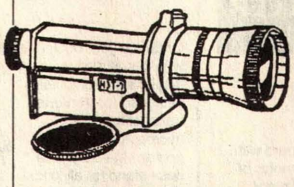
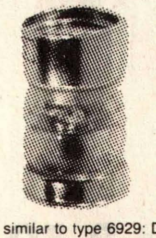
PASSIVE NIGHT VIEWER



This is a completed commercial monocular hand held night viewer. It employs an image intensifier tube with a luminous gain of 12500! The viewer is of a USSR military standard and will produce useful images in as little as starlight illumination. Has adjustable low light objective lens, adjustable eyepiece and is supplied with a carry case. Limited supplies at an incredible price of:

$549

INFRA RED TUBE AND SUPPLY

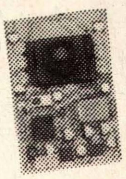


These are the key components needed for making an INFRA RED NIGHT VIEWER. The tubes will convert infra red light into visible light on the phosphur screen. These are prefocussed tubes similar to type 6929: Do not require a focus voltage. All that is needed to make the tube operational is a low current EHT power supply, which we provide in kit form: Draws 20mA from a small 9V battery.

INCREDIBLE PRICING:

$120

MINIATURE CCD CAMERA

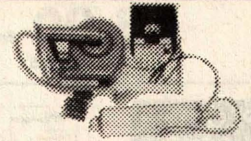


A monochrome CCD Camera that is totally assembled on a small PCB and includes an Auto Iris lens: Overall dimensions of camera are 24 X 54 X 120mm. The camera can work with as little as 0.1 lux illumination, and it is IR responsive! The six IR leds that are included on the P.C.B. are useful for producing good images in a totally dark room! Available in EIA or CCIR standards. **$140**

IMAGE INTENSIFIER TUBE

These 18mm image intensifier tubes are similar to ones used in night vision equipment during the Gulf War. They are ex-military and may have some minor blemishes on the viewing screen. With suitable low light lenses they will produce good vision in as little as starlight illumination. The tubes require a 3V battery to make them operational. **$340**

EHT GENERATOR KIT

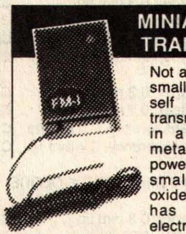


An experimenters delight! This extremely versitile kit will produce HT-EHT voltages: DANGER — HIGH VOLTAGE! With the addition of a few components this kit can also power small laser tubes, produce HT outputs etc. **12V DC at approximately 1A input ** Pulsed DC output with a peak output voltage of approximately 11KV * Add capacitor (.001uF/15KV) for 11KV DC output * 400V and 1300V pulsed outputs also available from taps on flyback transformer: Just add a suitable diode and a capacitor to obtain 400V or 1300V DC output ** Varying the 12V supply will also change all the mentioned voltages: Very handy! ** Instructions provided. Great for EHT experiments, replacement HT — EHT supplies, plasma balls, etc.

EHT GENERATOR KIT **$15**

Additional components for running small laser tubes $4, small used laser tube $15,0.001uF/15KV capacitor $3, 3KV/200mA diode plus 0.01uF/3KV capacitor for HT outputs: $2.

MINIATURE FM TRANSMITTER



Not a kit, but a very small ready made self contained FM transmitter enclosed in a small black metal case. It is powered by a single small 1.5V silver oxide battery, and has an inbuilt electret microphone.

Specifications: Tuning range: 88-108MHz, Antenna: Wire antenna-attached, Microphone: Electret condenser, Battery: One 1.5V silver oxide LR44/G13, Battery life: 60 hours, Weight: 15g, Dimensions: 1.3" X 0.9" X 0.4". Some would call this a miniature "BUG" and sell it for much more than our price of: **$25**

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Volt, Amp, Ohm
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Peak Hold
Auto power off
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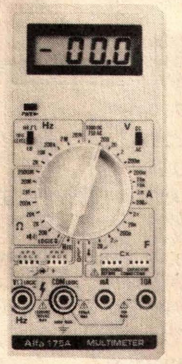
Rubber Holster $8.00



DMM 175A $67.95

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Most Popular DMM

Freq. Counter 1Hz-20MHz
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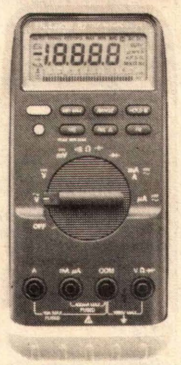
Resistance 0.1Ω-2000MΩ
Capacitance 1pF-20µF
TTL Logic test 20 MHz
Transistor HFE test
Diode test
LED test
3 1/2 digit display
10 MΩ impedance



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Fluke 75 II		$127
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Fluke 87	True RMS	$285
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LCR Meter 814
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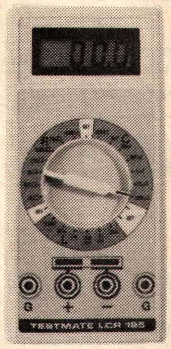
The Best Handheld LCR

Inductance: 0.1µH-200H
Capacitance: 0.1pF-20,000µF
Resistance: 1mΩ-20MΩ
1% basic accuracy
Dissipation factor indicates leakage in capacitor and Q factor in inductor
Zero adjustment to reduce parasitics from test fixture
Best for high frequency RF and surface mount components.
SMD and chip component test probe $25.00



LCR Meter 195
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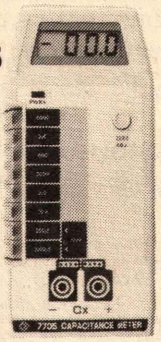
Very Popular LCR

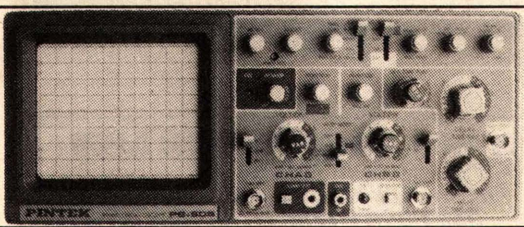
Inductance: 1µH-200H
Capacitance:0.1pF-200 µF
Resistance:0.01Ω-20MΩ
Basic accuracy:R:1%, C:2%, L:3%
Test frequency 1 kHz



Capacitance Meter 7705 $57.95

0.1 pF-20,000µF in 9 ranges
0.5% basic accuracy
Zero adjustment ± 20pF to compensate parasitics from test fixture

Also Available:
Heavy duty DMM, AC/DC clamp meter, Thermometer, Light meter pH meter,, High voltage probe Digital caliper, Anemometer Elctronic scale, Force guage Tachometer, Humidity & EMF adapter, Sound level meter Frequency counter, SWR/field strength/power meter, Dip meter



20 MHz Oscilloscope with Delay Sweep PS-205 $429.95

Dual Trace, Component test, 6" CRT, X-Y Operation, TV Sync, Z Modulation, CH2 Output, Graticule Illum, 2 probes each has x1,x10 switch. Best price with delay sweep.

PS-200 20 MHz DUAL TRACE	$339.95
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PS-405 40 MHz DELAY	$569.95
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20 MHz Digital Storage Oscilloscope DS-203 $729.95

Switchable between digital and analog modes
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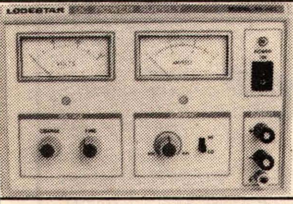
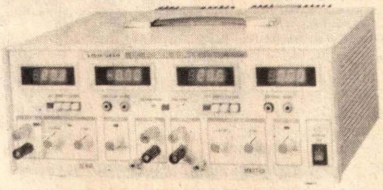
Sampling rate: 10 M sample /sec
8 bit vertical resolution (25 Lerel/div)
Expanded Timebase 10ms/div - 0.5 s/div
Refresh, Roll, Save all , Save CH2, Pre-Trig
Plotter Control



DC Power Supply PS-303 $159.00

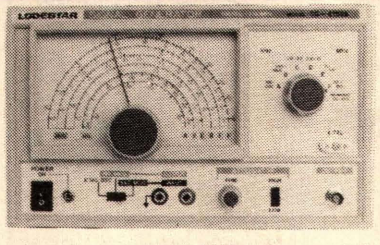
0-30 VDC , 0-3A output

0.02% + 2mV line regulation
0.02% + 3mV load regulation
1 mVrms noise and ripple
Short circuit and overload protected
PS-8200 with digital voltmeter $179.00
Also available: 30V/5A, 60V/3A, 60V/5A
16V/10A, 30V/10A



DC Power Supply Triple Output PS-8202 $499.95

Two 0-30 VDC , 0-3A outputs
One fixed 5VDC, 3A ouptput
Capable of independent or tracking operation
Constant voltage and constant current mode
Four digital meters for volt and current display
Excellent regulation and low ripple
Short circuit and overload protected
Also available: 30V/5A triple output
60V/5A dual tracking



RF SIGNAL GENERATOR SG-4160B $119.00

100 kHz-150MHz sinewave in 6 ranges
RF Output 100mVrms to 35 MHz
Internal 1kHz, External 50Hz-20kHz AM modulation
Audio output 1 kHz, 1 Vrms

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POWER
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RF SIGNAL GEN./COUNTER SG-4162 AD $229.95

Generates RF signal same as SG-4160B
Frequency counter 1Hz - 150 MHz for internal and external source
Sensitivity <50mV

AUDIO GENERATOR AG-2601A $119.00

10Hz - 1MHz in 5 ranges
Output: 0-8Vrms sinewave
0-10Vp-p squarewave
Synchronization: ±3% of oscillation frequency per Vrms
Output distortion:
0.05% 500Hz - 50kHz
0.5 % 50Hz - 500kHz
Output impedance: 600 ohm

AUDIO GEN./COUNTER AG-2603AD $229.95

Generates audio signal same as AG-2601A
Frequency counter 1Hz-150MHz for internal and external sources
Sensitivity <50mV

FUNCTION GENERATOR FG-2100A $169.95

0.2 Hz -2 MHz in 7 ranges
Sine, square, triangle, pulse and ramp
Output: 5mV-20Vp-p
1% distortion, DC offset ± 10V
VCF: 0-10V control frequency to 1000:1

FUNCTION GEN/ COUNTER FG-2102AD $229.95

Generates signal same as FG-2100A
Frequency counter 4 digits
Feature TTL and CMOS output

SWEEP FUNCTION GEN./COUNTER $329.95

0.5Hz to 5 MHz in 7 ranges
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1uF/25V	6¢
2.2uF/50V	6¢
3.3uF/25V	6¢
4.7uF/25V	7¢
10uF/25V	7¢
22uF/25V	7¢
33uF/25V	7¢
47uF/25V	8¢
100uF/25V	9¢
220uF/25V	10¢
330uF/25V	10¢
470uF/25V	10¢

20 pcs min per item

Deal 'A': 60pcs (5 ea) **$5**

Ceramic Disc

7¢ each
(Caps rated 50V)

10pF 220pF
22pF 330pF
27pF 470pF
33pF 1000pF
47pF .01uF
100pF .1uF

20 pcs min per item

Deal 'B': 60pcs (5 ea) **$4**

Tantalum Caps

1uF/35V	15¢
2.2uF/35V	17¢

10 pcs min per item

Deal 'C': 10pcs (5 ea) **$3**

VOLTAGE REGULATOR

7805	35¢
7812	35¢
7824	35¢
78L05	35¢
78L12	35¢

5 pcs min per item

Deal 'D': 15pcs (3 ea) **$6**

TRANSISTORS

PN2222A	6¢
PN2907A	6¢
2N3904	6¢
2N3906	6¢
2N4401	6¢
2N4403	6¢

50 pcs min per item

Deal 'E': 60pcs (10 ea) **$5**

MORE TRANSISTORS

2N2222A	25¢
2N3055	80¢

No minimum quantity

TOGGLE SWITCHES

Miniature size
1/4" Panel hole
Solder Lugs

on-on	SPDT	85¢
on-on	DPDT	95¢
on-off-on	DPDT	1.25

No minimum quantity

DIODES

1N914A	3¢
1N4148	3¢
1N4001 ... (1A/100V)	4¢
1N4004 ... (1A/400V)	5¢
1N4007 .... (1A/1kV)	6¢

20 pcs min per item

Deal 'F': 50pcs (10 ea) **$3**

MORE DIODES

1N5401 ... (3A/100V)	8¢
1N5404 ... (3A/400V)	9¢
1N5408 ... (3A/1kV)	10¢
6A20 ..... (6A/200V)	22¢
6A100 ..... (6A/1kV)	25¢

10 pcs min per item

Deal 'G': 25pcs (5 ea) **$5**

GERMANIUM DIODES

1N34A	10¢
1N270	20¢

10 pcs min per item

Deal 'H': 10pcs (5 ea) **$2**

T1 3/4 (5mm) Diffused LEDs

Red	7¢
Green	8¢
Yellow	9¢

20 pcs min per item

Deal 'I': 30pcs (10 ea) **$3**

CABLE TIES

4" Long	2¢
8" Long	4¢

50 pcs min per item

Deal 'J': 50pcs (25 ea) **$2**

PUSH BUTTON

Mini size - Red cap
Momentary - N.O.
1/4" Panel Hole

30¢ ea / 5pcs - 25¢ ea / 50+

DIP BRIDGE

400V / 1Amp
P/N: DF04M

35¢ ea / 5pcs - 30¢ ea / 50+

0.1uF / 50V MONO

6¢ ea / 20pcs - 5¢ ea / 100+

POWER CORD

18AWG - 3 Conductor - 6ft.
only .... $2.00 ea

SOLDER ROLL

SN63/37 - Multicore
21 Gage (.031" dia)
1 Lb roll - Great buy

$7.00 each

POPULAR I.C.'s

LM324	50¢
LM339	45¢
LM358	45¢
NE555	45¢
NE556	50¢
LM741	45¢
CD4001B	30¢
CD4011B	30¢
CD4013B	35¢
CD4017B	35¢
CD4028B	35¢
CD4066B	35¢
CD4069B	35¢

5 pcs min per item

Deal 'K': 26pcs (2 ea) .. **$12**

DB-25 SOLDER CUP

Gold Plated

Male	40¢
Female	45¢

5 pcs min per item

DB-25 HOOD

Hardware Included
40¢ ea
5 pcs min

Deal 'L': 6pcs (2 ea) **$3**

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- Powerful 2 stage audio amplifier.
- Sensitive, picks up sounds at the level of a whisper.
- Up to 1 mile range.

XST500 SUPER-MINIATURE FM TRANSMITTER

Worlds smallest FM voice transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip (SMT) parts are pre-assembled to the circuit board.

XST500(E-Z) Kit $44.95

- Smallest Phone transmitter anywhere!
- Tunes 88-108 MHz.
- No batteries required, powered by phone line.
- Up to 3/4 mile range.
- Attach to phone line anywhere in house, even inside phone.

XSP250 SUPER-MINIATURE PHONE TRANSMITTER

Worlds smallest FM phone transmitter. Use with any FM broadcast receiver. Easy to assemble, all chip (SMT) parts are pre-assembled to the circuit board.

XSP250(E-Z) Kit $34.95

- Digital voice changing: male to female, female to male, adult to child, child to adult.
- 16 levels of voice masking.
- Button for normal operation.
- Complete anonymity on all calls

TRANSITION 2000 VOICE CHANGING TELEPHONE

STOP THOSE ANNOYING PHONE CALLS! Sound older and tougher when you want to. Not a kit, fully assembled. Single line phone operation only.

TRANSITION 2000 .... $89.95

- Digital voice changing: male to female, female to male, adult to child, child to adult.
- Use with any modular phone.
- Connects between handset and phone.
- 16 levels of voice masking.

TRANSITION 2001 VOICE CHANGING Accessory

STOP THOSE ANNOYING PHONE CALLS! Sound older and tougher when you want to. Use with single or multi-line phones. Not a kit, full assembled.

TRANSITION 2001 .... $59.95

- Transmits both sides of phone conversation.
- Adjustable from 88-108MHz.
- Works with any FM broadcast receiver.
- Up to 1 mile range.
- Turns off when phone is not in use to extend battery life.

XTT100 LONG RANGE PHONE TRANSMITTER

Similar to our very popular XSP500, the XTT100 is battery powered for maximum range. It plugs into any phone jack and transmits all calls on that line.

XTT100(C) Kit $32.95

- Super sensitive, hear every sound in a house!
- Powerful 2 stage audio amp.
- Use with any FM broadcast receiver.
- Up to 1 mile range.
- Powered by 9V battery.

XFM100 MINIATURE FM TRANSMITTER

The XFM100 has a super sensitive microphone and is capable of picking up sounds at the level of a whisper and transmitting them to any FM broadcast receiver.

XFM100(C) Kit $32.95

- Transmits a continuous beeping tone.
- Adjustable from 88-108 MHz.
- Up to 1 mile range.
- Works with any FM broadcast receiver.
- Operates at battery voltages of 3 to 18 volts.

XTR100 TRACKING TRANSMITTER

Measuring .7 by 2.4 inches, the XTR100 is ideal for use in locating lost model rockets, bicycles, automobiles, games of hide-and-seek, and contests.

XTR100(C) Kit $43.95

- Uses sensitive microwave transistor amplifier.
- Covers 1 to 2000 MHz.
- Compact hand held unit.
- Uses Miniature loudspeaker (not included) for audio indication of detected signals.

XBD200 SUPER SENSITIVE BUG DETECTOR

When the XBD200 intercepts a signal in the 1 to 2000 MHz range, it emits a growl that increases to a high pitched squeal as the signal strength increases.

XBD200(C) Kit $49.95

XLC900 800-950 MHz SCANNER CONVERTER KIT

If your scanner can receive 400-550 MHz, just add the XLC900 for uninterrupted 800-950 MHz coverage. It converts all 800-950 MHz signals down to 400-550 MHz so your scanner can receive them! Add our custom case and knob kit for that "professional" look.

XLC900 Kit $49.95
XLC-Case Kit $13.95

XLA1000 AMPLIFIER KIT

Designed to help scanners with poor sensitivity pull in those weak signals. Includes off/pass switch for returning to normal operation and front panel gain control. Add our custom case and knob kit for that "professional" look.

XLA1000 Kit $24.95
XLA-Case Kit $13.95

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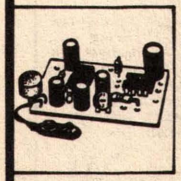
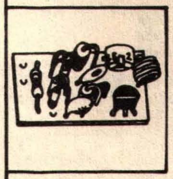


SUPER SNOOPER BIG EAR

Listen through walls, hear conversations across the room. Add a parabolic reflector & hear blocks away. The BIG EAR can be hidden about anywhere. Makes an ultra- sensitive intercom, Can be used as a 1.5W AMP. We supply a mini- electret mike in the kit. 1"x1.75" 6 to 12vDC

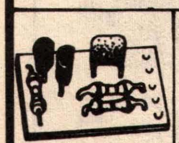
AA-1 **$10.95**



PHONE TRANSMITTER

Small but mighty, it fits anywhere. Phone line powered, never needs batteries. Transmits both sides of a phone conversation loud and clear, wireless, to any FM radio at great distances. Variable tunes from 70MHz TO 130MHz FM. You can also use it as a speaker phone. Size .5"x1"

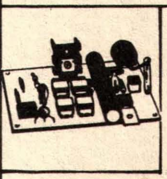
TEL-B1 **$12.95**



PHONE RECORDING SWITCH

This phone line powered switch is small enough to be installed any where. Every time the phone is picked up the recorder will record both sides of the conversation automatically. Use it in your office to record all phone calls so you don't loose important information. 1"x.6"

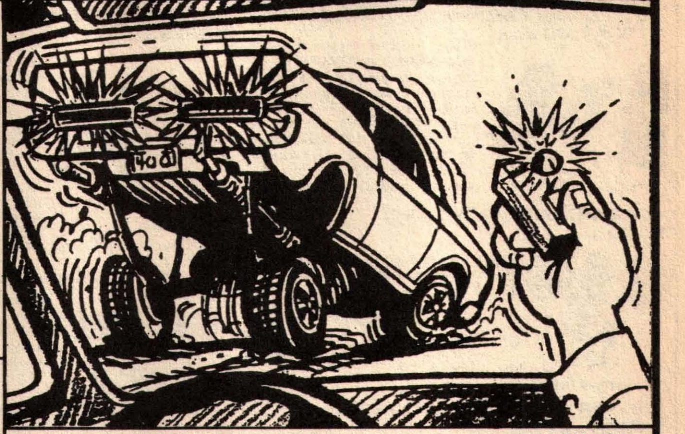
TEL-SW1 **$12.95**



STROBE LIGHT

Do you need an attention getter, warning light, or flashing light for model airplanes, then this kit is for you. Use it as an emergency light for your auto, radio tower, even use it on your bicycle. Has a variable flash rate. Size 3.5"x1.8" operates on 6 or 12v DC only.

ST-1 **$9.95**



THE ZAPPER activates any radar detector within 3/4 of a mile. Check the brake lights of that sports car that just went by 90 miles an hour. Back off those 18 wheelers trying to eat your back bumper. Put the fun back in driving. THE ZAPPER is a 10GHz amateur transmitter the size of a cigarette pack, operates on a 9v battery, when the button is pushed, brake lights and radar detector light the skies. Complete with the rules of the new ROAD WARRIOR GAME... TROLLING FOR TAILGATES, America's fastest growing highway participatory sport.

Built	**$49.95**
Kit	**$39.95**

DIGITAL THERMOMETER

The DT-3 kit will turn your digital volt meter into an accurate digital thermometer with .1 degree resolution. Measures temperature from -40F to 250F degrees. It has a remote sensor .25" SQ. and can be mounted many feet away from the meter. Size 1.5x1.2" 9vDC

DT-3 **$8.95**

CAPACITANCE METER

This kit will turn your digital volt meter into a capacitance meter. Turn that junk box of unmarked capacitors into a fortune of usable parts. Measures capacitors from <2.2pF to 2.2uF. 1.75"x2" 9vDC

CA-1 **$12.95**

VOLTAGE MONITOR

This kit has 7 multi-colored leds to monitor your 12, 8, or 5v DC systems. Build it to work in 1v, 1/2v, or 1/4v steps. Great for nicad packs, autos, boats, mobile homes, or battery chargers. P.C.B. 1.3"X2.7"

VM-1 **$7.95**

BLINKEY LIGHT

This kit is perfect for decorating hats, name badges, & model trains. Add a box, set it on the dash of your car, use it as an auto burglar alarm. Comes with 2 alternate flashing leds. Size .5"x.5" 9 to 12vDC

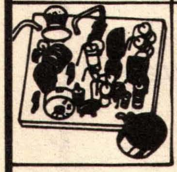
RB-2 **$3.95**

TV NOTCH FILTERS

Our TV filters eliminate unwanted TV channels or interference that alters both sound & video with a beep-beep-beep. Works on cable channels 2 thru 22. and the 'SNOOPER & BULLET.

Note: All TV Filter Kits are sold for educational purposes only. You must obtain permission from your local cable company before using these filters on your cable system.

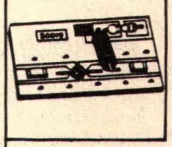
DF-222 Kit **$14.95**



WIRELESS FM MICROPHONE

Small but mighty, this little jewel will out perform most units many times its price. It really stomps out a signal. The WM-1 kit is a buffered wireless mike that operates from 80-MHz to 120MHz FM, the frequency of any broadcast FM radio. Includes a mini-electret mike. .8"x1" 6 to 12vDC

WM-1 **$14.95**



WIDE BAND PREAMP

Ideal for preamp for scanners, hand held radios, frequency counters. Amplifies low level (weak) signals. If the signal is extremely low 2 amps can be used in series. 1MHz TO 2.5MHz @ 2.8dB nf 1dB compression = +0 dBm gain: 1MGHz-20dB to 2.5GHz-6dB Requires 12vDC @ 16Ma

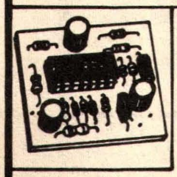
WBA-6 **$19.95**

RAINBOW KITS
☑SCHEMATICS
☑PARTS LAYOUT
☑P.C. BOARD LAYOUT
ELECTRONIC RAINBOW

This Manual contains all schematics, parts & P.C. board layouts for all of the Rainbow Kits. Use your own parts to construct any of our kits.

KIT BOOK **$14.95**

$5.00 off if you buy any kit



VOICE ACTIVATED SWITCH

This VOX circuit can be used to operate a tape recorder, ham radio, CB radio, or turn on an alarm. The VOX-1 kit has 100MA of output. That operates a relay, light, motor, or ? What could you do with a sound activated switch? Size 1.5"x1.3" 7.5 TO 18vDC

VOX-1 **$6.95**

INDUCTANCE METER

This is the kit every one has been asking for. Turn your digital volt ohm meter into an inductance meter. It will read inductors 3uH to 7MH. Size 1.5"x1.6" 9vDC

IA-1	$14.95
CABINET	$ 8.95

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Special offer with your purchase on Amplifier + (Toroidal) Transformer + Metal Cabinet/Capacitors!

Nuevo

New

300W MOSFET AUDIO MONO POWER AMPLIFIER
AF-3 ▲▲▲

Power Output: 300W into 4 ohms RMS (0.1% THD). 200W into 8 ohms RMS (0.02% THD) • Frequency Response: 10 Hz - 20 KHz. • Total Harmonic Distortion: Less than 0.03% • Input Sensitivity and impedance at 1 KHz, IV 47K • Load Impedance: 4 - 16 ohms. • Power Requirements: ±55 to ±65V DC 8A. May use Mark V Model 009 Transformer • Suggested Capacitor 10,000uf100V Model 019 • Suggested rack mount cabinet: Model LG-1925

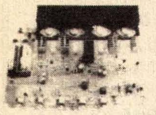
Kit: $165.00
Assembled & Tested: $195.00

120 W MOSFET POWER AMPLIFIER (MONO)
TA-477 ▲▲

T.H.D.: Less than 0.007% • Power Output: 120 watts into 8 ohms RMS • Frequency Response: 8 Hz - 20 KHz. + 0-0.4 dB • Sensitivity IV • Power Requirements: ±55 VDC @ 3 amps. May use Mark V Model 003 Transformer • Suggested Capacitor 10,000uf80V-100V Model 019 • Suggested rack mount cabinet: Model LG-1925

Kit: $68.00
Assembled & Tested: $85.00

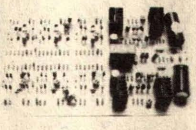
120W + 120W LOW TIM PRE AND MAIN STEREO AMP.
TA-800MKII ▲▲



Power Output: 120 watts RMS per channel into 4 ohms load. 72 watts RMS per channel into 8 ohms load • Frequency Response: 10 Hz - 20 KHz. • Total Harmonic Distortion: Less than 0.01% • Tone Control: Bass: ±12 dB. Mid: ±8 dB. Treble: ±8 dB • Sensitivity: Phono Input, 3 mv into 47K. Line, 0.3 v into 47K. Signal to noise ratio 86 dB • Power Requirements: 40V DC @ 6 amps. May use Mark V Model 001 or 008 Transformer • Suggested rack mount cabinet: Model LG-1924 or 1925

Kit: $63.92
Assembled & Tested: $73.95

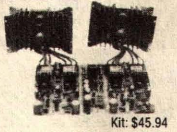
FULLY COMPLEMENTARY SYMMETRICAL FET STEREO PRE-AMP.
TA-377A ▲▲▲



Frequency Response: 10 Hz - 100 KHz. • RIAA Curve Deviation: ±0.2 dB, 30 to 15,000 Hz • Total Harmonic Distortion: Less than 0.007% at rated output • Channel Separation at 1 KHz: Better than 70 dB • Hum and Noise: Phono: Better than 70 dB, Aux: Better than 90 dB, Phono Sensitivity: 2 mV @ 47K • Output: 1.5V (0.01% T.H.D.) • Record Output: 150 mV • Maximum Output at 0.1% Distortion: 15V • Power Requirements: 30 V x 2 @ 400 ma. May use Mark V Model 010 Transformer • Power Consumption: 12W • Suggested rack mount cabinet: Model LG-1684 or LG-1983 • Suggested Volume Control: ALPS 100K ohm dual V.R., Model 022

Kit: $59.95
Assembled & Tested: $75.00

80W + 80W PURE DC STEREO MAIN POWER AMPLIFIER
TA-802 ▲▲



Power Output: 80 watts per channel into 8 ohms • Total Harmonic Distortion: Less than 0.05% at rated power. • Intermodulation Distortion: Less than 0.05% at rated power • Frequency Response: DC to 200 KHz. -0 db,- 3 db. @ 1 watt • Power Requirements: 30 VAC x 2 @ 6 amps. May use Mark V Model 001 or 008 Transformer • Suggested Capacitor 8,200uf50V Model 017 • Suggested rack mount cabinet: Model LG-1924

Kit: $45.94
Assembled & Tested: $59.72

VIDEO / AUDIO SURROUND SOUND PROCESSOR
SM-333 ▲▲★

Frequency Response: 20 Hz - 20 KHz. • Total Harmonic Distortion • Front Channel: 0.05% • Rear Channel: Less than 0.25% • Input Signal Voltage: 0.1 to 3.5V • Output: Front Channel: 0.1 to 3.5V • Rear Channel: 6.6V • Delay Time: 5 to 50 milliseconds • Input Impedance: 47K • Power Requirements: 100-120 VAC, 60 Hz (Case & Transformer are included)

Kit: $73.00
Assembled & Tested: $85.00

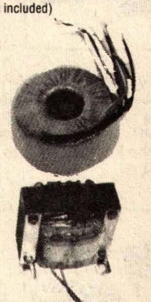
60W + 60W STEREO POWER AMP. (WITH MIC. & GUITAR INPUT)
SM-302 ▲▲★

Frequency response: 20Hz to 20 KHz • Total Harmonic Distortion: <0.1% • Power output 60W per channel into 4 ohm load RMS • 33W per channel into 8 ohm load RMS • Input Sensitivity: Mic/Guitar 10 mv • Hi 380 mv • Lo 640 mv • Signal to noise ratio: Better than 70 db • Power Consumption: 100W. (Case & Transformer are included)

Kit: $73.00
Assembled & Tested: $85.00

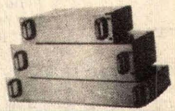
(TOROIDAL) TRANSFORMERS**

MODEL	DESCRIPTION	
#001	28V x 2 6A, 30V x 2 6A	$28.00
#002	36V x 2 3A	$23.00
#003	40V x 2 6A	$30.00
#004	24V x 2 6A	$23.00
#005	26V x 2 3A	$17.00
#006	18V x 2 5A	$17.00
#007	53V x 2 8A	$45.00
#008**	28V x 2, 30V x 2 6A	$38.00
#009**	48V x 2, 53V x 2 8A	$66.00
#010	30V x 2, 36V x 2 400mA	$ 8.50
#011**	9V x 2, 22A	$60.00



METAL CABINETS WITH ALUMINUM FRONT PANEL

MODEL	H"	x W"	x D"	
LG-1273	3"	12"	7"	$23.85
LG-1684	4"	16"	8"	$28.50
LG-1924	4"	19"	11½"	$34.50
LG-1925	5"	19"	11½"	$38.00
LG-1983	2¾"	19"	8"	$32.50



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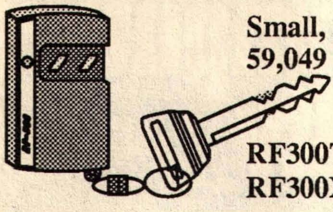

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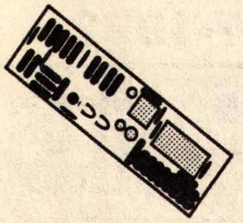

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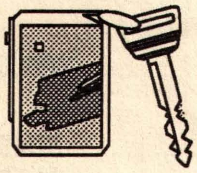

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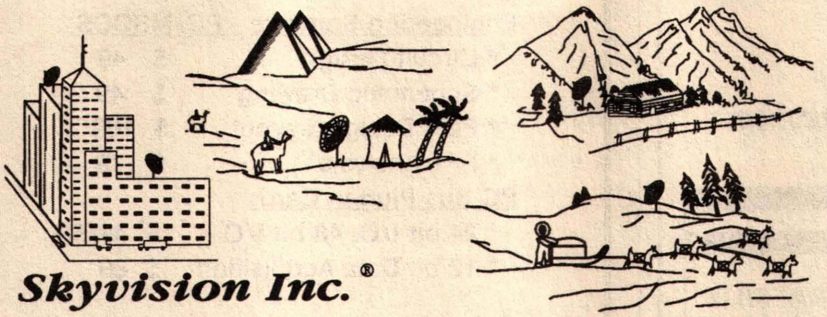

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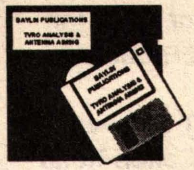

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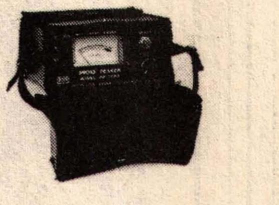

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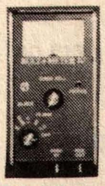

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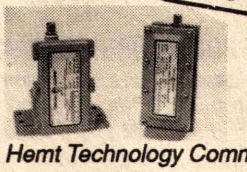

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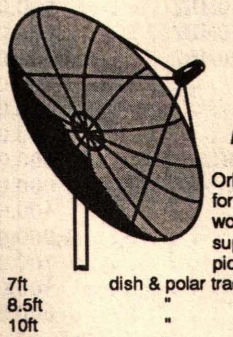

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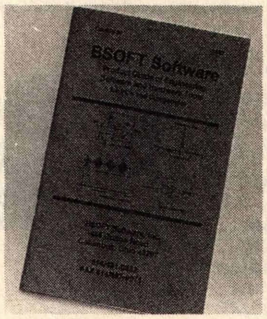

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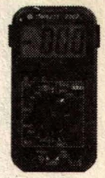

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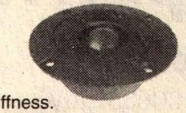
Polydax 1" Soft Dome Tweeter



1" textile diaphragm features a catenary profile for maximum stiffness. Ferro fluid cooling ensures high power handling capability with smooth and transparent sound reproduction. •Power handling: 70 watts RMS/ 100 watts max. •Voice coil diameter: 1 inch wImpedance: 8 ohms •Frequency response: 4000-20,000 Hz wMagnet weight: 8-1/2 ozs. •Fs: 1200 Hz wSPL: 92 1W/ 1m •Net weight: 1 lb. •Manufacturer model number: TWO25M1 •Dimensions: A: 3-7/8", B: 2-7/8", C: 1", D: 2-3/4", E: 3/4".

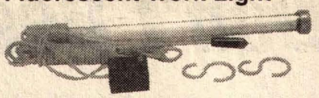
#EN-270-046 **$21.95** (1-9) **$19.50** (10-UP)

High Voltage Cap Kit

This 85 piece kit contains a selection of 250, 350, and 450 volt electrolytic capacitors. 5 pieces each of 1, 2.2, 3.3, 4.7, 6.8, 10, 22uf and 2 pieces each of 33, and 47uf, 250V radial caps. 5 pieces each of 1, 2.2, 3.3, 4.7, 10uf and 2 pieces each of 22, 33uf, 350V radial caps. 5 pieces each of 1, 2.2, 4.7uf and 2 pieces of 10uf, 450V radial caps. Net weight: 1 lb.

#EN-020-950 **$49.95** EACH

Fluorescent Work Light



Extra bright 15 watt tube that operates on 120 VAC or 12 VDC. 15 foot power cord with wall adaptor and cigarette lighter plug. Net weight: 2 lbs.

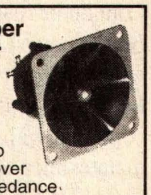
#EN-360-490 **$17.90** EACH

12 VDC Cooling Fans

Perfect for cooling car audio power amps. Standard mounting configuration for replacement. Manufacturer may vary.

Part #	Description	Price (1-9)	Price (10-UP)
EN-250-102	micro fan 1" x 2-3/8" x 2-3/8"	$8.50	**$7.95**
EN-250-160	mini fan 1" x 3-5/8" x 3-5/8"	9.90	**8.90**
EN-259-120	standard fan 1-1/2" x 4-5/8" x 4-5/8"	9.90	**8.90**

Motorola Super Horn Tweeter



Very popular super horn tweeter found in many systems. Piezo elements do not require crossover networks and impedance increases as the input decreases. Excellent power handling capability. •Power handling: 50 watts RMS/ 75 watts max. •Frequency response: 4000-27000 Hz •SPL: 94 dB 1W1/1m •Net weight: 2 ozs. •Manufacturer model number: KSN1005 •Dimensions: A: 3-3/8" x 3-3/8", B: 3" C: 2-5/8", D: 1-3/4", E: 1".

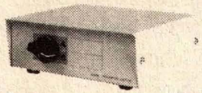
#EN-270-010 **$4.50** (1-9) **$3.95** (10-UP)

8" Fiberglass Cone Bass/Midrange

A premium quality driver. The woven fiberglass cone, high loss rubber surround and 29 Hz resonance, combine to offer excellent sonic definition and deep, tight bass.
•Power handling: 70 watts RMS/100 watts max
•Voice coil diameter: 1-1/2 inches •Impedance: 8 ohms
•Frequency response: 29-4000 •Magnet weight: 20 ozs.
•Fs: 29 Hz •SPL: 89 dB 1W/1m •Vas: 2.98 cu. ft. •Qts: .39 •Qes: .47 •Qms: 2.2 •Xmax: .17 inches •Net weight: 5 lbs.
•Dimensions: A: 8-3/8", B: 7-1/4", C: 3-13/16", D: 3-7/8", E: 1 3/8".

#EN-296-095 **$55.80** (1-3) **$51.50** (4-UP)

RS-232 A-B Switch



Fully shielded, steel enclosed data switch with gold plated female connectors. All 25 pins switched through. Can be used to switch multiple printers or computers. 1 year guarantee. Net weight: 1-3/4 lbs.

#EN-130-010 **$10.50** (1-2) **$9.95** (3-UP)

Fuji Alkaline AA

Premium quality super alkaline batteries from Fuji feature a 100 percent mercury free formula. Long life design retains up to 85 percent of its life after 5 years in storage. Sold in packages of four.

#EN-140-155 **$2.30** (1-9) **$2.05** (10-UP)

Home VCR Repair Illustrated

This illustrated guide can show you how to correct the most common VCR malfunctions without expensive tools or test equipment. Written by Richard C. Wilkins and Cheryl A. Hubbard. 400 pages in paperback. Copyright: 1991.

#EN-500-165 **$19.95** EACH

6-1/2" Two-Way Inwall System

This is our most popular in-wall. Easily installed in any 2 x 4 or larger wall. Specifications: 6-1/2" poly woofer with a 10 oz. magnet, 1" field replaceable soft dome tweeter. Integral 2-way crossover with pushbutton wire terminal. 8 ohm impedance, frequency response: 40-20,000 Hz. 40 watts RMS/80 watts max power handling capability. Sensitivity: 90 dB 1W/1m. Dimensions: 8-1/2" (W) x 12" (L) x 3 1/2" (D). Net weight: 9 lbs. per pair.

#EN-300-036 **$249.95** (SUG. LIST) **$119.50** (1-3 PRS) **$109.90** (4 PRS-UP)

12" Heavy Duty Poly Woofer

Special clear ribbed polypropylene cone with poly foam surround. •Power handling: 100 watts RMS/200 watts max. •Voice coil diameter: 2 inches •Impedance: 6 ohms •Frequency response: 23-1500 Hz wMagnet weight: 40 ozs. •SPL: 96 dB 1W/1m •Vas: 12.68 •Qts: .16 •Xmax: .098 •Qes: .18 •Qms: 1.86 •Fs: 23 Hz •Net Weight: 9 lbs. •Manufacturer model number: A30GU40-51D •Dimensions: A: 12-1/8", B: 10-7/8", C: 5-1/2", D: 5-1/2", E: 1-3/4".

#EN-290-125 **$41.80** (1-3) **$39.90** (4-UP)

Right Angle 1/4" Phone Plug

(Mono)

#EN-099-020 **65¢** (1-49) **40¢** (50-up)

The Loudspeaker Design Cookbook IV

This book describes the "science" of loudspeaker design, however applying it is an "art". Using the information in this book will yield hundreds of possible variations in speaker design, with some subtle and not-so-subtle differences. 1991 copyright, fourth edition. Author: Vance Dickason. 154 pages paperback.

#EN-500-035 **$29.95** EACH

Cabinet Carpet

This high quality carpet is the covering of choice for car, stage, and amplifier cabinets. Adhere with spray adhesive or latex contact cements. Sold by the linear yard. 54" wide.

#EN-260-765 Dark Charcoal
#EN-260-767 Medium Grey
#EN-260-768 Jet Black

Per Linear Yard, 36" x 54" **$4.50**

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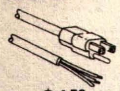
Parts Express
International Inc.

14-3 Heavy Duty Cord



Super duty power cord. 14 ga., 3 conductor. 4 ft. length. Limited availability.

#EN-119-010 $2.50 (1-9) **$1.50** (10-UP)

12 VAC CT, 300 mA Transformer

12VAC (6-0-6) secondary. 300 mA current capability. 2-1/2 ft. primary wires. Dimensions: 2-1/2"(W) X 1-3/8"(H) X 1-1/2" (D).

#EN-129-340 $1.95 (1-9) **$1.70** (10-UP)

VCR Hardware Assortment

Convenient assortment of clips, washers, springs, and screws. 10 pieces each of 4 sizes of "E" clips, 10 pieces of 2 sizes of retaining rings, 10 pieces of 14 sizes of washers, 2 each of 8 sizes of tension and compression springs and 24 assorted screws. Total of 246 pieces.

#EN-430-315 $6.50 (1-3) **$5.95** (4-UP)

Speaker Sealing Caulk

Special rubber compound quickly and easily seals speakers into cabinets. Eliminates vibration and air leaks. Sold in 1/4" x 36" strips.

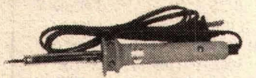
#EN-269-300 75¢ (1-9) **60¢** (10-UP)

Klein Unibit (reg) Step-Drill Bit

For drilling multiple size holes in metal, plastic and wood up to 1/8" thick. Thirteen steps in 1/32" increments ranging from 1/8" to 1/2" holes. Diameter markings are laser etched on the flute. 1/4" shaft.

#EN-362-100 **$18.95**

Quality 30 Watt Iron



Economical 30 watt iron with replaceable tip. Blue plastic handle.

#EN-370-010 **$4.90**

Soldering Stand

Convenient soldering iron stand with cleaning sponge. Display boxed.

#EN-370-020 $4.95 (1-9) **$4.50** (10-UP)

Kester Pocket Pack

Perfect tool box solder supply. The wire feeds conveniently from the handy dispenser tube. Pocket clip attached. .031" diameter solder. .5 ounce (approximately 15 feet).

#EN-370-050 $1.00 (1-9) **90¢** (10-UP)

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Dayton, Ohio 45402
Local: 513-222-0173
FAX: 513-222-4644

Isotip Butane Soldering Iron

The ideal soldering iron for field repairs where no AC power is present. Uses standard butane (not included) available at most stores. Iron also comes with a torch attachment which easily screws on in place of the soldering tip. Limited one year warranty.

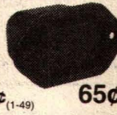
#EN-370-235 **$24.95** EACH

Center Off Toggle

DPDT center off toggle switch. 6A, 125VAC. (1/2" mount.)

#EN-060-087 $1.50 (1-9) **$1.25** (10-UP)

Monitor Power Jack



Standard computer type monitor jack. Limited quantity.

#EN-090-446 85¢ (1-49) **65¢** (50-UP)

Screw Type Holder

Standard AGC type fuseholder. Fits 5/8" mounting hole. Black color.

#EN-070-610 65¢ (1-9) **55¢** (10-UP)

Pull-Out Radio Carry Case

Super quality nylon bag storing pull out radios. Front accessory storage pocket which will hold up to 5 CD cases. Velcro closure. Inside dimensions: 7-1/2" x 2-1/2" x 8".

#EN-265-950 $10.80 (1-3) **$9.95** (4-UP)

Matching Transformer

Adapts 75 ohm coax to 300 ohm twin lead (or vice-versa) at antenna or television. 5-90 MHz UHF/VHF. 3 capacitor PC board type.

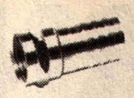
#EN-180-010 49¢ (1-49) **35¢** (50-UP)

Deluxe F-59 Connector

(Full attached ferrule)

#EN-090-355 22¢ (1-49) **17¢** (50-UP)

Deluxe "F" Male For RG-6



(Full attached ferrule)

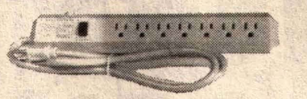
#EN-090-358 29¢ (1-49) **24¢** (50-UP)

Technician's Turntable

Turntable to speed repair of VCRs, TVs and more. Allows technician to easily turn unit for convenient repair. Dimensions: 20"W x 15"D x 1-1/8"H. Black pebbled surface. Includes 4 anti-skid adhesive feet. Net weight: 9 lbs.

#EN-360-427 **$26.80** (EACH)

Surge Protected Power Center



7 outlet power center with noise and surge protection. Surge protection on all three lines (hot, neutral, ground). response time: less than 8 nano seconds. Noise protection on hot to neutral. 15 amp circuit breaker. Lighted power switch. UL listed.

#EN-130-212 $12.50 (1-9) **$10.95** (10-UP)

Universal Video Cable

6 ft. RG-59 cable with a push-on "F" connector to a combination 75 and 300 ohm balun that is switchable between 75 and 300 ohm.

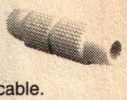
#EN-180-126 $2.95 (1-9) **$2.60** (10-UP)

3.5mm Mini Headphone Extension

Add 6 feet to your mini headphones. Gives the user added mobility when listening to personal cassette players. Limited availability.

#EN-240-090 $1.65 (1-9) **$1.30** (10-UP)

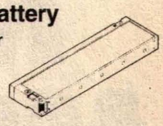
In-Line Coax Splice



Quickly splice coaxial cables with this unique and easy to use splice connector. Accepts up to RG6/U cable.

#EN-090-545 49¢ (1-49) **55¢** (50-UP)

12V, 2.3Ah Camcorder Battery



Popular battery for use with Canon, Chinon, Curtis Mathes, G.E., Magnavox, Minolta, Olympus, Panasonic, J.C. Penny, Pentax, Philco, Quasar, Sears, Sylvania, Teknika and other miscellaneous manufacturers. Dimensions: 7.17" (L) x .94" (W) x 2.42" (H).

#EN-140-541 **$39.95** EACH

Carpet Spray Adhesive

Professional quality spray adhesive securely bonds lightweight materials such as flexible foams, fiberglass insulation, plastics and metal foils. 16.5 oz. aerosol.

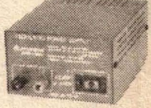
#EN-340-095 $8.90 (1-11) **$7.90** (12-UP)

Pressfit Speaker Terminal

Spring loaded, pushbutton speaker terminal simply drill a hole, apply glue, and press into place.

#EN-260-295 95¢ (1-9) **78¢** (10-UP)

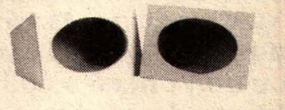
3 Amp Power Supply



This is a fully regulated power supply perfect for testing car radios, CBs, radar detectors and other standard 12VDC items. Heavy duty steel housing with indicator lamp and binding posts. Short circuit protection. Input 120 VAC, 60 Hz. 2 year warranty. Net weight: 4 lbs. Specifications: output voltage 13.8 VDC, output current (cont) 3 amps, output current (surge) 4 amps, dimensions 4-1/2"x3"x7", net weight 4 lbs.

#EN-120-495 $24.80 (1-3) **$23.50** (4-UP)

Unfinished 6" x 9" Cabinets



You can paint or finish to your liking. Flush mount design for rear deck baffle applications. Dimensions: 11-5/8" x 8-3/8" x 6-3/4" x 5" (tapered back). Sold in pairs. Approximate cubic volume: .2 cu. ft. Net weight: 9 lbs. per pair.

#EN-260-450 $12.50 (1-3 PRS) **$9.95** (4 PRS-UP)

Triple Shielded Audio Cables

These high grade oxygen free copper cables utilize triple shielding to ensure excellent noise rejection and are terminated with high conductivity gold plated RCAs for maximum signal transfer. Flexible jacket is sapphire blue and includes a remote turn on wire.

#EN-263-650 (3.3 ft.)	$15.50 (1-3)	**$13.90** (4-UP)
#EN-263-655 (6.8 ft.)	$17.50 (1-3)	**$15.90** (4-UP)
#EN-263-670 (19.8 ft.)	$29.90 (1-3)	**$25.50** (4-UP)

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Tek 7L18 1.5-60 GHz........$4,195.00
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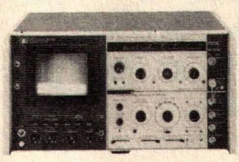

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HP 432...(power meter)..............$395.00
HP 436A...(incl.cable & sensor).$1,595.00
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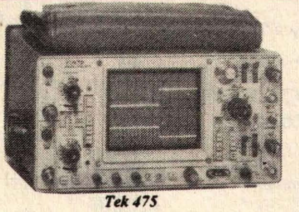
EMCV10V 500A..............................$1,495.00
EMCV 20V 500A.............................$1,295.00



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TEK 475A...250MHZ.....$1,095.00
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TEK 2465.....300MHZ.....$2,995.00

LAB SCOPES

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TEK 7603.....200MHZ(includes 2 ea. 7A18 & 7B53A.........................$850.00
7A18 dual trace vert. amp............$195.00
7A19 vertical amplifier................$395.00
7A22 differential amplifier...........$495.00
7A26 dual trace amplifier.............$295.00
7B53A delayed sweep time base..$295.00
7B80 delayed time base................$300.00
7B92A dual time base...................$450.00
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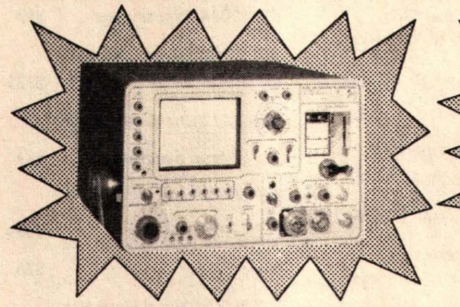
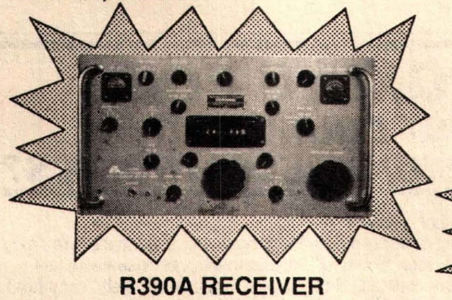


INDUSTRY STANDARD TEKTRONIX 491 SPECTRUM ANALYZER

Covers 10 Mhz - 40 Ghz. Solid state portable unit features internal phase lock, minimum sensitivity is - 100 dBm. A 12.4 Ghz mixer is included with each unit. External mixer kit, and attenuators are available with purchase of each 491 for $400.00 extra per set. **Price: $1,200.00 ea.**



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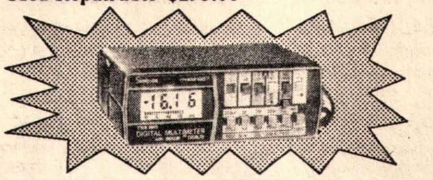

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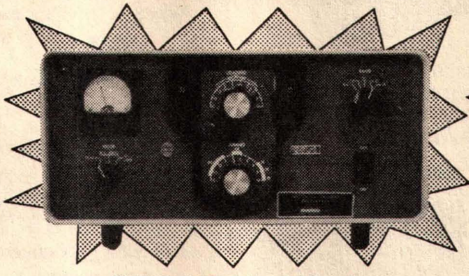

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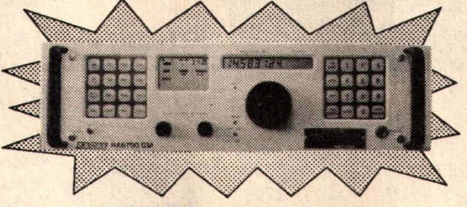

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RA 6790/GM

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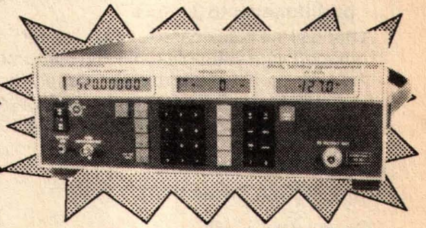

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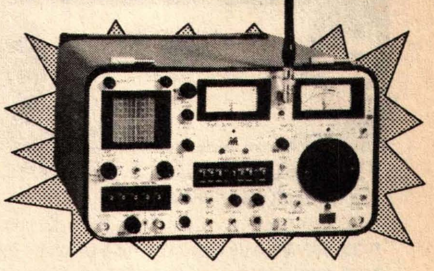

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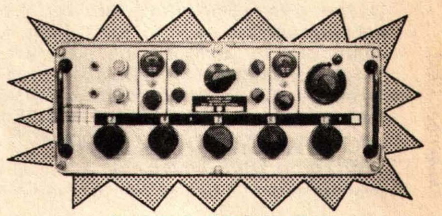

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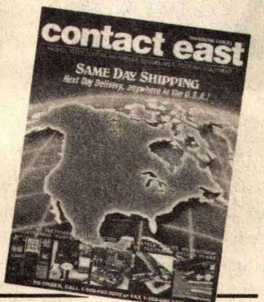

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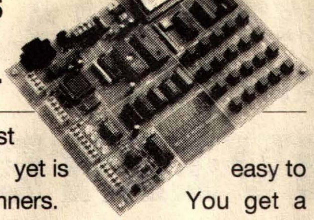

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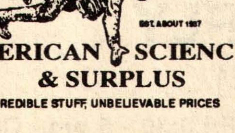

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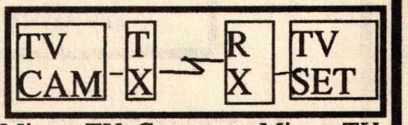

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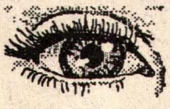

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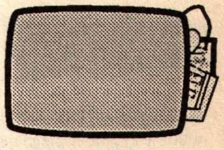

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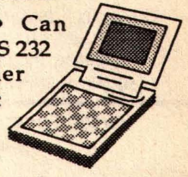

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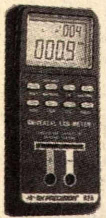

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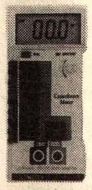

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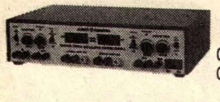

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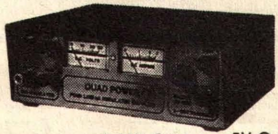

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Assembled $7
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All the desired features for doing experiment
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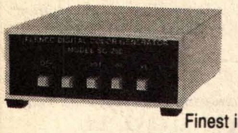

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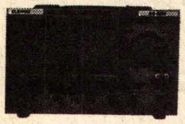

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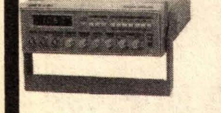

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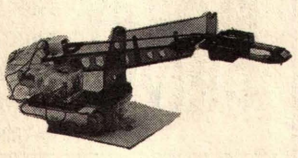

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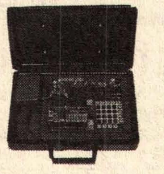

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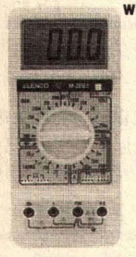

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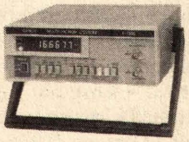

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- Frequency adjustable in five ranges from 1 to 100KHz
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- Modulation FM-AM

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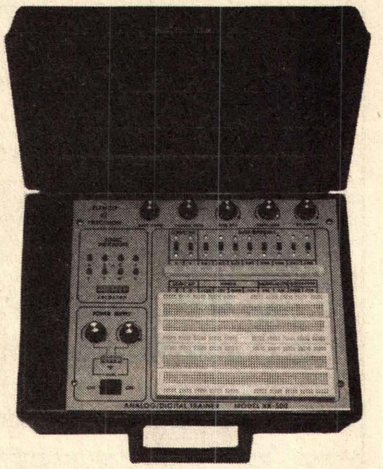

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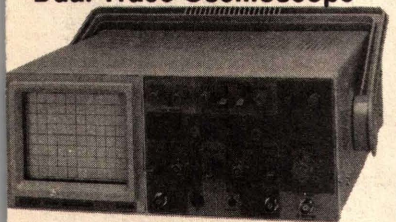

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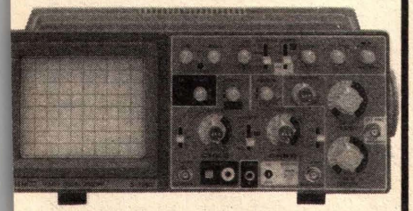

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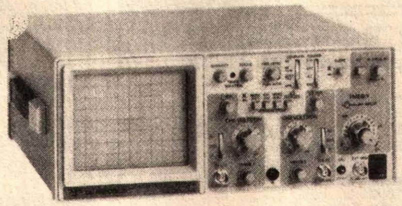

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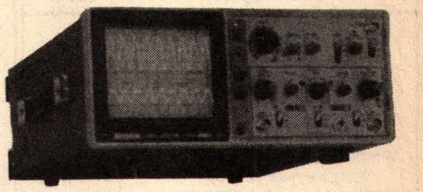

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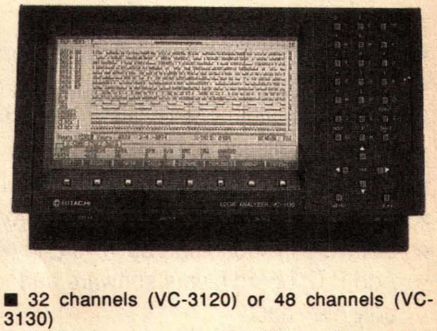

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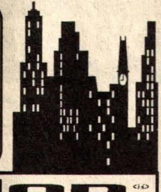

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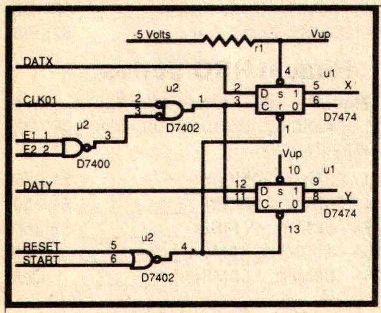

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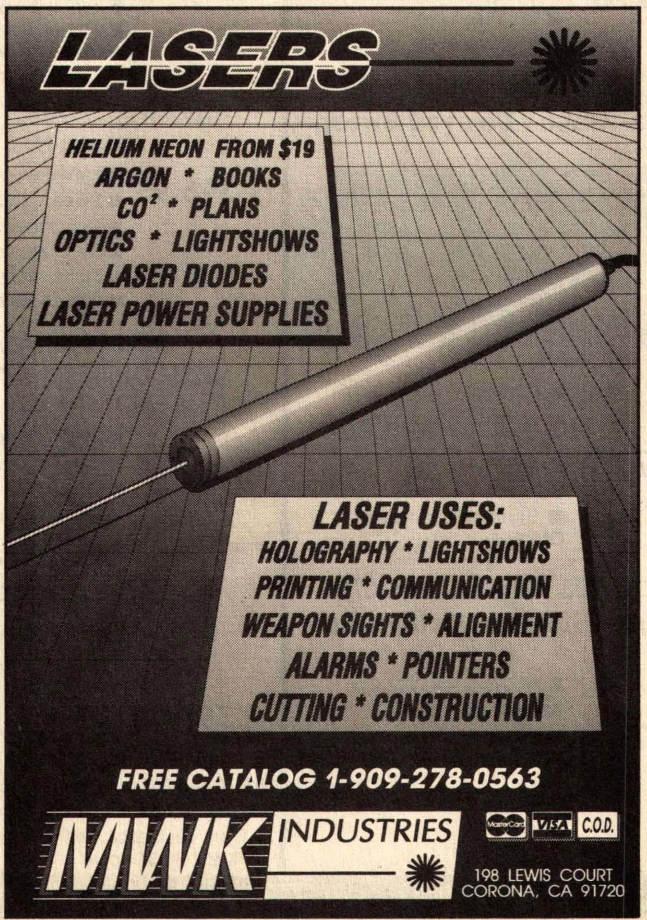

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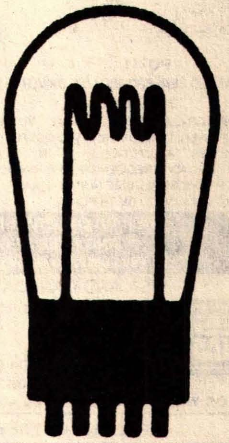

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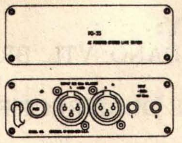

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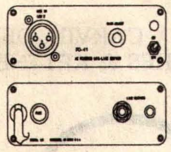

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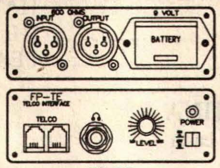

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	100	500	2000
2N3904	.06	.05	.04
2N3906	.06	.05	.04
2N4401	.06	.05	.04
2N4443	.06	.05	.04
PN2222A	.06	.05	.04
PN2907A	.06	.05	.04
2N3055	.67	.62	.55

DIODES

	200	1000	5000
1N4001	.02	.017	.015
1N4004	.023	.02	.017
1N4007	.026	.023	.019
1N4148	.019	.016	.011
1N47XX	.06	.05	.045
	50	100	500
6A10	.21	.17	.15
6A100	.28	.24	.21
1N34A	.09	.08	.06
1N60	.09	.08	.06
1N270	.19	.16	.13
1N5401	.067	.06	.052
1N5408	.079	.07	.061

REGULATORS

	50	200	1000
7805	.33	.27	.22
7812	.34	.28	.23
7818	.34	.28	.23
7824	.34	.28	.23
7905	.33	.27	.22
7912	.34	.28	.23
LM317T	.55	.48	.42

IC's

	100	500	1000
TIL111	.32	.28	.24
LM555	.35	.31	.27
LM339	.33	.29	.25
4011B	.20	.18	.15
4013B	.22	.20	.17

LED's

3mm OR 5mm

	100	500	1000
RED	.07	.065	.06
GREEN	.08	.075	.07
YELLOW	.09	.085	.08
7 SEG DISPLAY	.50	.45	.35
LED HOLDER 3 OR 5mm	.07	.06	.05

CAPACITORS

RADIAL LYTIC - 25VDC

	100	500	1000
1 uF	.04	.035	.03
2.2 uF	.04	.035	.03
3.3 uF	.05	.04	.035
4.7 uF	.05	.04	.035
6.8 uF	.05	.04	.035
10 uF	.05	.04	.035
22 uF	.06	.05	.04
33 uF	.06	.05	.04
47 uF	.06	.05	.04
100 uF	.07	.06	.05
220 uF	.09	.08	.07
330 uF	.09	.08	.07
470 uF	.10	.09	.08
1000 uF	.22	.20	.18

CRYSTALS

	100	500	1000
2.000 MHZ	.45	.40	.35
3.579 MHZ	.45	.40	.35
4.000 MHZ	.45	.40	.35
4.910 MHZ	.45	.40	.35
5.000 MHZ	.45	.40	.35
7.370 MHZ	.45	.40	.35
10.00 MHZ	.45	.40	.35
11.059 MHZ	.45	.40	.35
12.000 MHZ	.45	.40	.35

IC SOCKETS

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	100	500	1000
6 PIN	.04	.035	.03
8 PIN	.04	.035	.03
14 PIN	.07	.065	.05
16 PIN	.08	.075	.06
18 PIN	.09	.085	.07
20 PIN	.10	.095	.08
24 PIN	.12	.105	.09
28 PIN	.13	.125	.11
32 PIN	.11	.095	.08
40 PIN	.20	.190	.17
42 PIN	.22	.205	.19

BRIDGES

	20	50	100
KBL005	.48	.42	.35
DF04M	.27	.24	.22
2W10M	.35	.30	.26
KBPC6005	.60	.53	.46
KBPC8005	.84	.67	.60
BR1005	.75	.66	.58
KBPC1501	1.68	1.48	1.28
KBPC3502	1.98	1.78	1.58

TOGGLE SWITCHES

	10	100	500
SPDT	.70	.60	.50
SPDT-OFF	.80	.70	.60
DPDT	.80	.70	.60
DPDT-OFF	1.21	1.07	.93
PUSH BUTTON	.28	.25	.23

MONO CAPS

	100	500	1000
.01uF 50V	.05	.04	.035
.1uF 50V	.05	.04	.035

TANTALUMCAPS

	100	500	1000
1uF 25V	.12	.10	.08
2.2uF 25V	.12	.10	.08

CERAMICCAPS

10pF - 22pF - 47pF - 100pF,
220pF - 470pF - .001uF - .01uF -
.022uF - .047uF - .1uF

	100	500	1000
each	.054	.04	.035

DIP SWITCHES

	10	100	500
DIPSW-04	.58	.52	.48
DIPSW-06	.67	.61	.57
DIPSW-08	.70	.64	.60
DIPSW-10	.85	.79	.75

SOLDER ROLLS

	1	10	20
SOLDER15	7.50	6.75	6.00
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CABLETIES

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CBLTIE-8"	.04	.03	.019
CBLTIEPAD	.12	.11	.09

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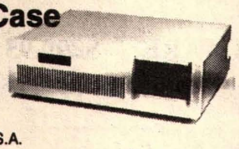

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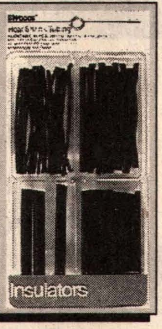

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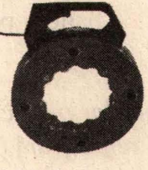
No. 280-0182F $4.95 ea.

Electricians 50 ft. Fish Tape



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7417	.40
7420	.40
7422	.54
7423	.54
7425	.40
7426	.40
7427	.40
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7432	.42
7433	.56
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7444	1.24
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74LS49	2.69
74LS51	.30
74LS54	.34
74LS55	.34
74LS63	.89
74LS73	.45
74LS74	.34
74LS75	.38
74LS76	.45
74LS78	.59
74LS83	.59
74LS85	.59
74LS86	.29
74LS90	.45
74LS91	.69
74LS92	.65
74LS93	.49
74LS95	.59
74LS96	.59
74LS107	.45
74LS109	.48
74LS112	.45
74LS113	.45
74LS114	.45
74LS122	.57
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74LS124	2.69
74LS125	.45
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74LS132	.45
74LS133	.59
74LS136	.49
74LS137	.59
74LS138	.49
74LS139	.49
74LS145	.69
74LS147	1.59
74LS148	.69
74LS151	.49
74LS153	.49
74LS154	1.29
74LS155	.59
74LS156	.59
74LS157	.47
74LS158	.38
74LS160	.38
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74LS162	.55
74LS163	.55
74LS164	.59
74LS165	.69
74LS166	.65
74LS168	.99
74LS169	.99
74LS170	.69
74LS173	.45
74LS174	.49
74LS175	.45
74LS181	1.99
74LS189	4.95
74LS190	.59
74LS191	.59
74LS192	.69
74LS193	.69
74LS194	.69
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74LS243	.69
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74LS245	.79
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74LS248	.79
74LS249	1.29
74LS251	.59
74LS253	.59
74LS256	1.00
74LS257	.49
74LS258	.55
74LS259	.69
74LS260	.59
74LS261	4.95
74LS266	.45
74LS273	.79
74LS275	2.19
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74LS280	.99
74LS283	.65
74LS290	.65
74LS293	.65
74LS295	1.09
74LS298	.79
74LS299	1.59
74LS322	1.59
74LS323	1.59
74LS324	2.09
74LS327	1.09
74LS348	.99
74LS352	1.09
74LS353	.99
74LS363	2.29
74LS364	1.09
74LS365	.45
74LS366	.45
74LS367	.45
74LS368	.45
74LS373	.75
74LS374	.75
74LS375	.99
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74LS378	.99
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74LS385	2.09
74LS386	.55
74LS390	.89
74LS393	.79
74LS395	.89
74LS396	.89
74LS399	.89
74LS424	4.00
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74LS465	1.09
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74LS540	.99
74LS541	.99
74LS573	1.39
74LS574	1.29
74LS590	4.95
74LS595	5.95
74LS612	1.99
74LS620	2.99
74LS623	1.49
74LS624	2.19
74LS629	2.69
74LS640	1.09
74LS641	1.50
74LS643	1.28
74LS645	1.09
74LS646	2.39
74LS668	1.39
74LS669	.99
74LS670	.89
74LS674	14.95
74LS682	2.19
74LS683	2.19
74LS684	1.69
74LS685	8.00
74LS688	2.19
74LS689	3.50
74LS783	25.00
74Sxx	
74S00	.35
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74S04	.35
74S05	.35
74S10	.25
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74S37	.25
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74S40	.35
74S51	.40
74S64	.35
74S65	.50
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74S86	.25
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74S157	.55
74S158	1.00
74S161	1.00
74S163	.50
74S174	.45
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74S189	1.89
74S195	.55
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74HC00	.30
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74HC32	.35
74HC51	.30
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74HC85	.89
74HC86	.40
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74HC154	1.29
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74HC193	.79
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74HC240	.69
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74HC541	.89
74HC573	1.39
74HC595	1.29
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74HC688	1.09
74HC4017	.99
74HC4020	.89
74HC4024	.99
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74HC4049	.69
74HC4050	.69
74HC4051	1.29
74HC4060	.89
74HC4075	.49
74HC4511	2.19
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74HCT573	.89
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'HCT4017	.79
'HCT4020	.79
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'HCT4060	.89
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4009	.79
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4011	.30
4012	.30
4013	.35
4014	.69
4015	.49
4016	.49
4017	.59
4018	.59
4019	.47
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4555	.79
4556	.79
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4560	1.69
4561	2.00
4566	2.00
4569	2.69
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4584	.69
4585	.79
4702	9.95
4724	1.19
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14175	.60
14409	12.95
14410	6.95
14411	7.95
14412	6.95
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14451	1.50
14490	4.95
14497	6.95
LINEAR	
TL071	.65
TL072	.69
TL074	.99
TL081	.55
TL082	.55
TL083	1.09
TL084	.95
LM150K	4.95
XR215	1.50
MAX232	4.95
MAX233	8.95
LM301	.49
LM307	.49
LM308	.79
LM309H	2.95
LM309K	1.50
LM310	1.69
LM311	.49
LM312H	5.50
LM316	4.00
LM317K	1.99
LM317T	.79
LM318	1.09
LM319	1.19
LM322	1.19
LM323K	3.39
LM324	.40
LM329	.79
LM331	5.95
LM334	1.19
LM335	1.39
LM336	1.29
LM337K	2.95
LM337T	.99
LM338K	4.95
LM339	.49
LF347	.75
LM350K	3.99
LM350T	2.99
LM350H	9.95
LF351	.55
LF353	.65
LF355	.99
LF356	.89
LF357	.95
LM358	.59
LM359	2.19
LM376	1.39
LM380	1.09
LM381	3.95
LM382	2.49
LM383	2.95
LM384	2.09
LM385Z12	1.69
LM386	1.19
LM387	1.89
LM389	1.29
LM390	1.59
LM392	.99
LM393	.45
LM395K	9.95
LF398	1.99
LF411	.75
LF412	1.19
TL489	1.59
TL494	1.89
TL496	1.59
TL497	2.09
NE531T	1.99
LM555	.38
LM556	.59
LM558	.79
NE564	1.69
LM565	1.59
LM566	1.39
LM567	.69
NE570	2.99
NE571	2.09
NE590	2.69
NE592	.50
NE602	1.95
MAX690	7.95
MAX691	8.95
LM709	.69
LM710	.79
LM711	.89
LM723	.69
LM723H	1.29
LM733	.69
LM741	.38
LM741HC	1.09
LM747	.69
LM748	.69
LM1014	2.69
LM1303	1.69
LM1310	1.69
MC1330	1.69
MC1349	2.09
MC1350	1.09
MC1358	.99
MC1372	2.69
MC1374	2.00
MC1404	1.99
MC1405	1.99
MC1411	1.99
LM1414	1.69
MC1456	1.50
MC1458	.47
LM1488	.50
LM1489	.50
MC1496	.99
MC1558	2.59
MC1648	.90
MC1723CL	1.00
MC1733CL	1.00
LM1800	2.69
LM1812	7.95
LM1830	4.95
LM1871	5.95
LM1872	6.95
LM1877	3.95
LM1889	3.95
LM1896	1.99
ULN2001	.79
ULN2003	.79
ULN2004	.79
XR2206	3.99
XR2207	4.25
XR2208	2.69
XR2211	2.69
XR2240	1.69
XR2242	1.50
XR2567	2.50
LM2877	2.19
LM2878	5.95
LM2900	2.19
LM2901	.69
LM2907	1.69
LM2917	2.19
CA3018	1.50
CA3037	1.50
CA3039	1.99
CA3046	.99
CA3059	2.39
CA3060	2.95
CA3065	1.70
CA3080	1.09
CA3081	.79
CA3082	1.09
CA3083	1.09
CA3086	.99
CA3089	1.59
CA3096	1.09
CA3130	.99
CA3140	.89
CA3146	1.09
CA3160	.99
CA3161	1.99
CA3162	6.00
CA3183	.99
CA3401	1.50
MC3302	.75
MC3340	1.69
MC3346	1.99
MC3360	1.50
MC3373	1.09
MC3401	.90
MC3403	.70
MC3470	1.29
MC3480	9.95
MC3486	1.09
MC3487	1.09
LM3900	.69
LM3905	1.39
LM3909	1.69
LM3911	1.99
LM3914	2.29
LM3915	2.49
LM3916	2.49
MC4001	4.00
MC4016	2.75
MC4024	2.79
MC4044	4.99
MC4136	1.19
MC4741	.50
ICM7216	30.00
ICM7231	9.95
ICM7551	.89
ICM7556	1.49
ICL7660	1.99
ICL7663	4.25
ICL7665	4.25
ICL8038	3.79
ICL8211	2.49
LF13741	.99
MC145026	1.99
MC145027	2.89
MC145028	2.89
7106	5.95
7107	5.95
7207	7.95
7208	20.00
7109	9.95
75107	.79
75108	.89
75110	.89
75138	1.69
75150	1.29
75154	1.29
75160	3.75
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75365	.89
75450	.99
75451	.49
75452	.59
75453	.59
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75477	.89
75491	.89
75492	.89
75493	.99
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TRANSISTORS	
VN10	1.95
C203YY	1.00
IRF353	8.25
IRF541	3.00
2N697	.70
MPS918	.25
2N2218	.50
2N2219	.50
PN2222	.20
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MPS2369	.29
2N2905	.50
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2N3567	.55
2N3568	.25
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PN3643	.25
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2N3703	.25
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2N3730	.50
2N3772	1.99
2N3866	1.20
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2N4123	.30
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2N4220	1.00
2N4236	1.59
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2N4919	.30
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2N5109	1.50
2N5222	.35
2N5306	.50
2N5308	.50
2N5401	.35
2N5484	.35
2N5550	.35
2N5819	.50
2N5840	6.00
2N5875	2.00
2N5878	2.49
2N6037	.45
2N6043	1.85
2N6045	1.85
2N6107	1.10
2N6124	1.00
2N6251	4.00
2N6292	1.10
MPS6513	.20
2N6719	.50
TIP29	.70
TIP30	.59
TIP31	.59
TIP32	.59
UARTS	
NS16450	6.95
NS16550	12.95

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1N4005 600PIV 1A DIODE	***20/1.00***
40 PIN SOLDER TAIL IC SOCKET	***.15***

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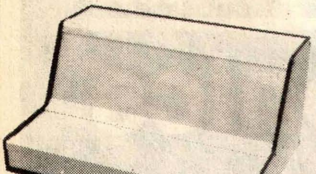

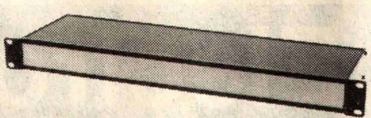

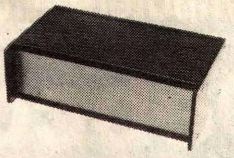

DUAL SLOPE METAL CABINETS

MODEL	DESCRIPTION MAJOR DIM. SECONDARY DIM. W x D x H x H1 x S1 x S2 x D1 (in.)	PRICE $
DS-1	4 x 6 x 4 x 1.2 x 1.9 x 2.4 x 1.6	59.00
DS-2	6 x 6 x 4 x 1.2 x 1.9 x 2.4 x 1.6	63.25
DS-3	8 x 6 x 4 x 1.2 x 1.9 x 2.4 x 1.6	67.50
DS-4	10 x 6 x 4 x 1.2 x 1.9 x 2.4 x 1.6	71.50
DS-5	12 x 6 x 4 x 1.2 x 1.9 x 2.4 x 1.6	76.00
DS-6	18 x 6 x 4 x 1.2 x 1.9 x 2.4 x 1.6	81.00
DS-7	4 x 8 x 6 x 2 x 3.1 x 3.5 x 1.9	69.00
DS-8	6 x 8 x 6 x 2 x 3.1 x 3.5 x 1.9	73.00
DS-9	8 x 8 x 6 x 2 x 3.1 x 3.5 x 1.9	78.00
DS-10	10 x 8 x 6 x 2 x 3.1 x 3.5 x 1.9	82.75
DS-11	12 x 8 x 6 x 2 x 3.1 x 3.5 x 1.9	87.75
DS-12	18 x 8 x 6 x 2 x 3.1 x 3.5 x 1.9	100.75

EXTRUDED SERIES

MODEL	DESCRIPTION W x D x H (inches)	PRICE $
ET-1	4.52 x 4.35 x 1.57	10.00
ET-1B	4.52 x 4.35 x 1.57	10.00
ET-2	4.52 x 6.00 x 1.57	24.00
ET-2B	4.52 x 6.00 x 1.57	24.00
CCET	PLASTIC CARRYING CASE	18.00

PANELS ARE .063" ALUMINUM

RACK CHASSIS

MODEL	DESCRIPTION W x D x H (inches)	PRICE $
1RU5	19 x 5 x 1.75	30.85
1RU7	19 x 7 x 1.75	33.10
1RU10	19 x 10 x 1.75	35.25
2RU5	19 x 5 x 3.5	33.10
2RU7	19 x 7 x 3.5	35.25
2RU10	19 x 10 x 3.5	37.50
3RU5	19 x 5 x 5.25	41.90
3RU7	19 x 7 x 5.25	44.10
3RU10	19 x 10 x 5.25	46.30

SHEET METAL PUNCHES

MODEL	HOLE SIZE & SHAPE	PRICE $
PUNCH 1	3/8" ROUND	9.95
PUNCH 2	7/16" ROUND	9.95
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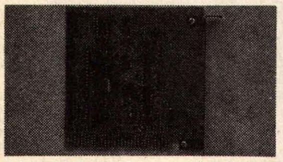

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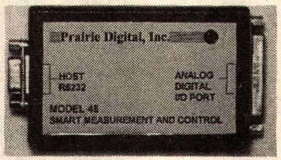

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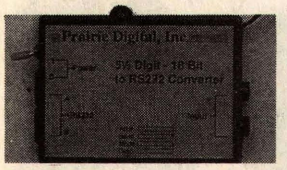

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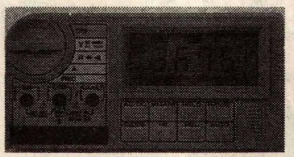

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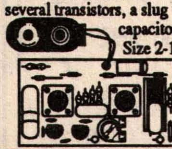

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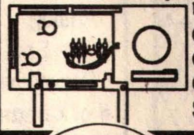

G3256 "Somewhere my love"
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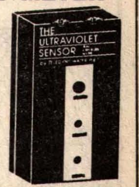
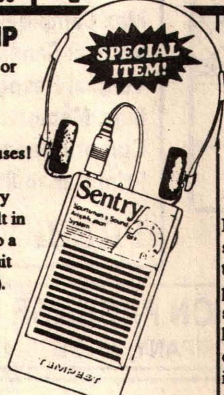


G934 $5.00 10/ $45.00

SUPER SNOOPER AMP

Have you ever wanted to hear the slightest sounds or whispers in a room? Now you can with the revolutionary new Sentry Sound Booster! The brochure says that it's great for use by hunters to listen for wildgame, however it has many other uses! Its like being able to have super human hearing on demand. Unit looks like a portable radio and is very stylish in design. Features sensitivity control, a built in parabolic dish which focuses the sound energy onto a very sensitive electronic microphone. Has IC circuit which operates from one 9V battery (not included). Comes complete with lightweight earphones and instructions. Size 4" x 2 1/4" x 1 1/8". New in Retail Box.



G3377 $21.95

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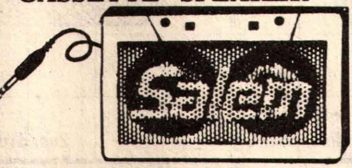

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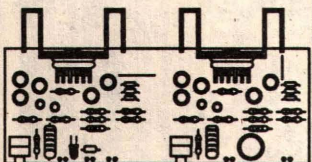

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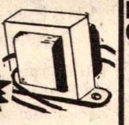

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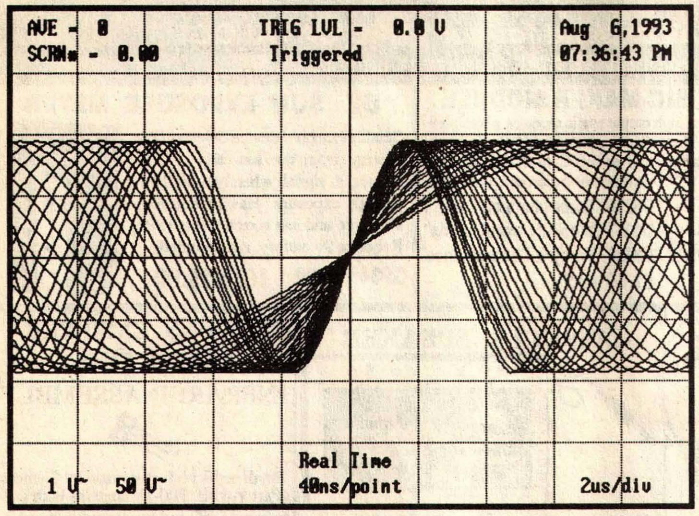

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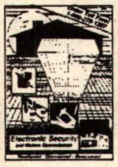

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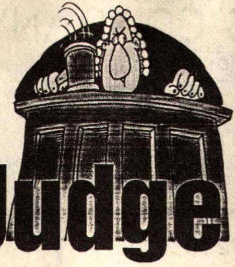

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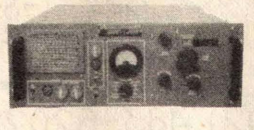

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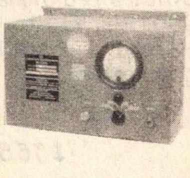
ME-165 SWR POWER METER



ME-165 SWR POWER METER for HF transmitter tests. Provides 52 ohm 600 watt load with SWR of 1.1:1 or less up to 30 MHz using 12/600 ohm non-inductive 50 W resistors. Has 0-600 W meter, function switch, and N connections. 13.5x9.8x9.8, 20 lbs sh.

USED	**$45**
GOV'T-RECONDITIONED	**$125**
Manual	**$8.50**

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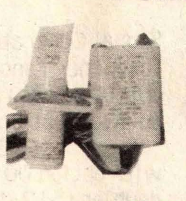

Strobe uses exciter which operates from 3 to 18 VDC 500 MA and has mount base that will fit on broomstick. Change plug to a car lighter plug and strobe makes great emergency light for car or boat! Bulb size: 1.5"H x 1.3" dia; cord 60". 3 lbs.

#SDU-30/E, unused	**$24.95**
LIGHTER DC CORD & PLUG, 15 ft.	**$4.00**

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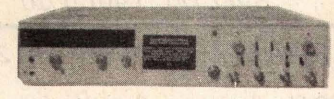

HEWLETT-PACKARD 5328AF/096 FREQUENCY COUNTER with opt 030 for 5-512 MHz freq-range 15 MV sensitivity and opt 011 for HP-1B computer interface. Has 9-digit LED display and resolution 0.1 Hz-1 MHz in 8 decade steps. Channels A & B 100 MHz module have 1-10-100 ATTEN and Marker output. Requires 120/240 V 48-66 Hz. 3.5x18.5x19, 28 lbs sh.

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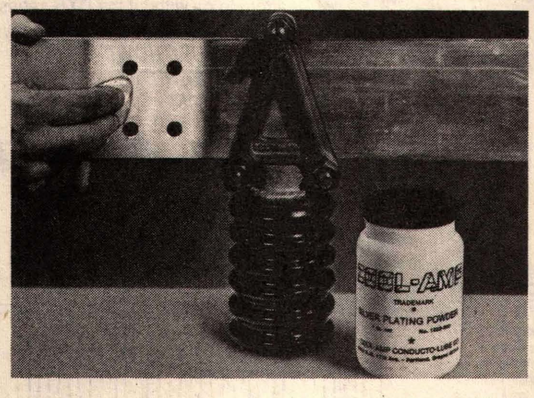

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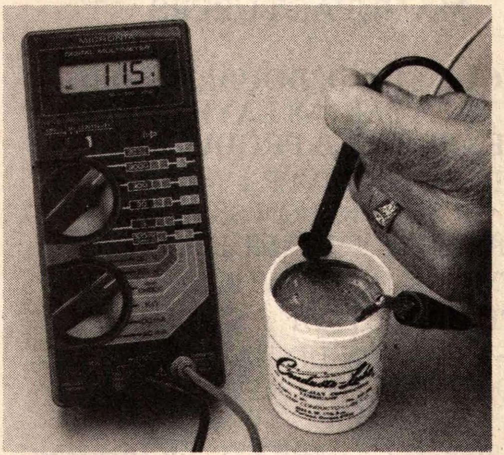

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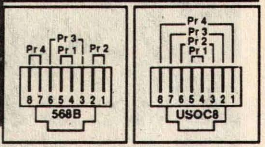

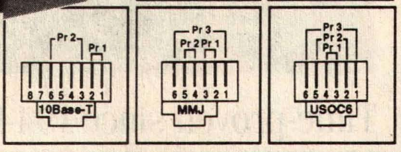

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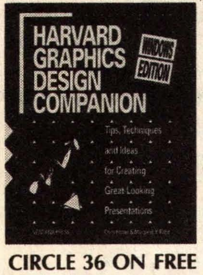
NEW LITERATURE

HARVARD GRAPHICS DESIGN COMPANION: WINDOWS EDITION; by Chris Potter and Margaret Y. Rabb. Ventana Press, P.O. Box 2468, Chapel Hill, NC 27515; Phone: 919-942-0220; Fax: 919-942-1140; $23.95.

The Windows version of Harvard Graphics Design adds an array of new graphic and typographic capabilities. This book will help readers take full advantage of those features to create effective and visually appealing presentations. It introduces readers to the Windows features and explains how to put them to work. Five chapters discuss various visual communication elements, such as the use of color palettes, chart and graph frames, rules, boxes, type treatments, text and table frames, graphics, and background treatments.

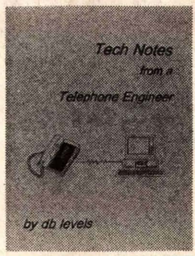

HARVARD GRAPHICS DESIGN COMPANION
WINDOWS EDITION
Tips, Techniques and Ideas for Creating Great-Looking Presentations

CIRCLE 36 ON FREE INFORMATION CARD

The book goes on to offer examples of presentations, including slide shows, overheads, screen shows, video-projector presentations, and Hypershows. A "Do's and Don'ts" chapter provides tips on what works and what to avoid, and "Frame Makeovers" offers step-by-step instructions for redesigning various presentation forms. Readers are guided quickly and painlessly through the procedures for designing and creating tables, two- and three-dimensional charts and graphs, and scatter plots. Dozens of sharp, original color and black-and-white illustrations accompany the text, which includes a glossary and an index for quick reference.

Tech Notes from a Telephone Engineer; by D. B. Levels. D. B. Levels, P.O. Box 1125, Tallevast, FL 34270-1125; $18.95.

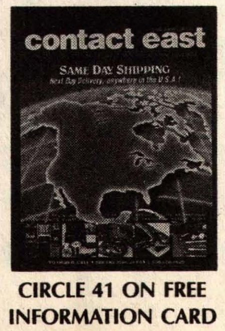
Telephone systems have become increasingly complex, and there seem to be new service options offered every week. The book was written to provide enlightenment for end-user technicians. It begins with a thorough explanation of how telephones work, both in the home and office and at the phone companies' centers. The book goes on to cover various aspects of telephone technology that are of interest to service technicians as well as phone users. It reveals precisely what customers are being charged for each month; where noise and static originates and how it can be eliminated; what causes crosstalk and RF interference; how to protect the phone system from lightning and voltage surges; and provides an overview of telephone-based home-office gear, including faxes and modems. The book goes on to explore the "bells and whistles" available on today's phones, and when it makes sense to buy your own telephone system. Finally, the book offers detailed information on wire and cable, and a wealth of troubleshooting tips.



CIRCLE 40 ON FREE INFORMATION CARD

1993 General Catalog. Contact East, Inc., 335 Willow Street South, North Andover, MA 01845-5995; Phone: 508-682-2000; Fax: 508-688-7829; free.

This 204-page catalog is brimming with hundreds of new test instruments and tools for plant and facilities operators, maintenance directors, engineers, production managers, and purchasing agents. It features brand-name products—from such manufacturers as Fluke, Tektronix, Weller, 3M, Microtest, and Simpson—for testing, repairing, assembling, and maintaining electronic equipment. Highlighted in the 1993 catalog are new insulated hand tools, cordless power tools, thermometers, DMM's, powerline monitors, uninterruptible power supplies, telecommunications tools and test equipment, tool kits, safety cabinets for storing flammable and corrosive materials, portable digital storage scopes, wire sorters, network testers, and ESD-safe ergonomic chairs. Also featured are full lines of test equipment, soldering/desoldering systems, shipping containers, measuring tools, ozone-safe cleaners, inspection equipment, workbenches, and batteries.



CIRCLE 41 ON FREE INFORMATION CARD

ECG Audio and Video Replacement Parts and Service Aids. Philips ECG, 1025 Westminster Drive, Williamsport, PA 17701; Phone: 800-526-9354; free.

Philips ECG's newly expanded line of audio and video replacement parts and service aids are described in the fourth edition of this catalog, which cross references 31 popular VCR and camcorder brands and more than 3500 industry model/part numbers to the corresponding ECG replacement parts. Those

continued on page A68

ECG
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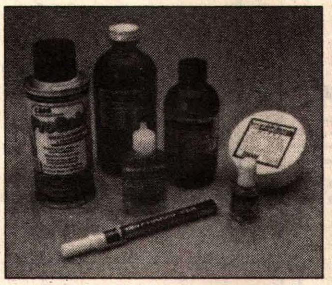

ProGold is specifically formulated to improve conductivity and protect gold, base metals and other precious metal surfaces. Use on gold connectors and contacts for maximum performance and protection. A common problem with gold plated surfaces is that the base metals migrate to the surface due to gold's soft and porous nature (dendrite corrosion). Once exposed, base metals oxidize, adding unwanted resistance that impedes electrical performance. Since gold plated surfaces are thinly coated, they are susceptible to scratching & abrasion, further exposing the base metals.

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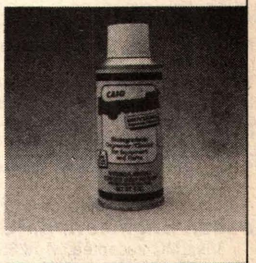

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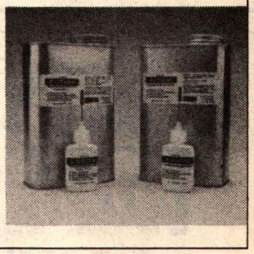

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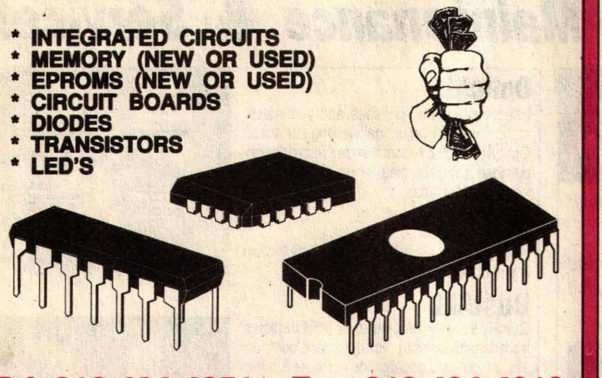

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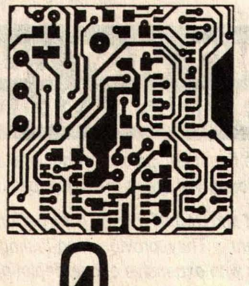

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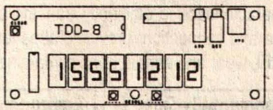

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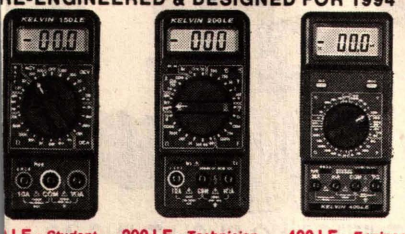

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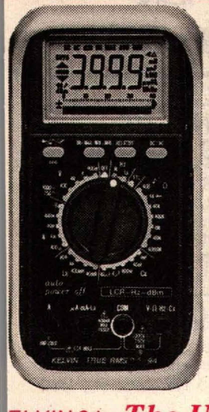

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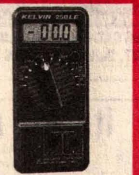

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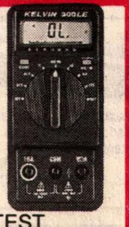

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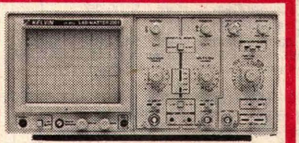
- RESISTANCE
- CONTINUITY TEST
- DIODE TEST 3 1/2 Digit LCD
- 10M ohm INPUT IMPEDANCE

INSTRUMENTS



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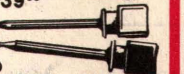

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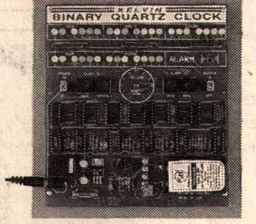

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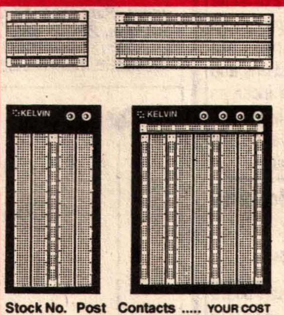

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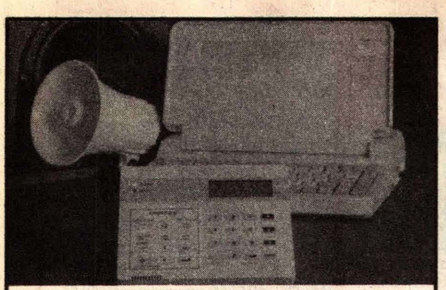

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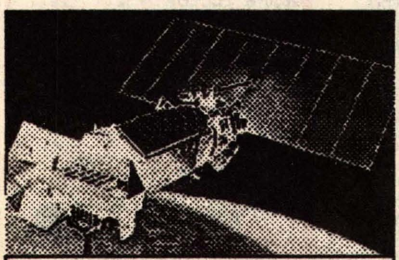

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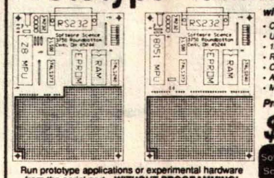

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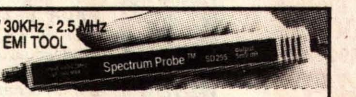

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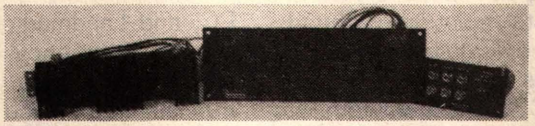

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  Typically only 28K is needed, but will vary with various setups
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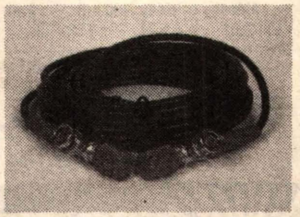

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NEW LITERATURE

continued from page A62

parts include VCR modulators, pinch rollers, optosensing devices, idler wheels/assemblies and tires, springs, E-clip and washer kits, individual belts and belt kits, and VHS and Beta replacement heads. Also featured are service aids, including VCR tools, VCR and audio test cassettes, alignment jigs, lubricants, and cleaning materials. Additions to the line include a compression spring kit, a felt washer kit, head pullers for VHS-C and 8mm camcorders as well as for standard VHS units, a retaining ring puller, and a spring hook. The mechanical parts replacement line has also been expanded. The catalog contains product descriptions, pictorial selector guides, specifications, cross-reference sections, and related replacement information.

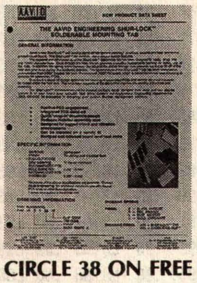
1992–93 ELECTRONIC EQUIPMENT, TOOLS & SUPPLIES CATALOG. Print Products International, Inc., 8931 Brookville Road, Silver Spring, MD 20910; Phone: 800-638-2020; Fax: 800-545-0058; free.

If your eyes are bigger than your wallet when it comes to electronic test equipment and tools, this catalog of discounted merchandise from several well-respected manufacturers can help bridge the gap. Its 68 pages include video test gear from B+K, Compuvideo, Hitachi, Kenwood, and Leader; computer equipment, software testers, EEPROM programmers and testers, and logic testers from A.R.I, C.S.T., Beckman Industrial, Dysan, B+K, Logical Devices, Tripplite, Proto PC, and Landmark; multimeters, frequency counters, oscilloscopes, spectrum analyzers, and function generators from Avcom, Vector, Simpson, Leader, Kenwood, Fluke, C.G. Soar, Beckman, Hameg, B+K, and others. Each item is represented by a photograph, a description of the device and its applications, and price.

CIRCLE 39 ON FREE INFORMATION CARD

Self-Locking Tabs Data Sheet. Aavid Engineering, Inc., One Kool Path, P.O. Box 400, Laconia, NH 03247-0400; Phone: 603-528-2400; Fax: 603-528-1478; free.

This data sheet provides application and specification data for Aavid's Shur-Lock self-locking tabs, designed to secure any heat sink to a printed-circuit board. The solderable tabs snap easily into any 0.093-inch diameter hole, lock with an audible snap, and will not fall out, even if the board is turned upside down. The data sheet features photographs, ordering information, and general information about each available style.



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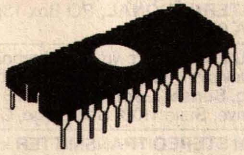

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PFS2 Plans .... $8.00 PFS2K Kit/Plans $49.50

$pecial Offer PFS20 Assembled reg $89⁵⁰; **$59.50**

TV & FM Joker / Jammer

- Shirt pocket device allows you to totally control and remotely disrupt TV or radio reception. Great gag to play on family or friends. Discretion required.

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High brightness red HeNe laser visible for miles. **Produce your own light show!** Projects a beam or red lite clearly visible in most circumstances. Can be used to intimidate by projection of a red dot on target subject. Also may be used to "listen in" using our laser *window bounce* method #LLIS1 below. **Easy to Build Modules Makes A Working Visible Laser:**

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allows you to hear sounds from an area via a lite beam reflected from a window or other similar object. System uses our ready-to-use LATR1 Laser Terminator gun site as the transmitter. The receiver section is supplied as an easy-to-build kit, including our cushioned HS10 headsets. **Order # LLIST20 System, includes our LATR1 Ready-to-Use Laser Gun Site, LLR1K Special Receiver Kit, and HS10 Headset, all for only $299.50**

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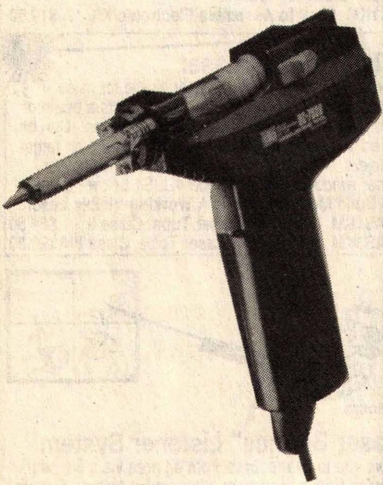

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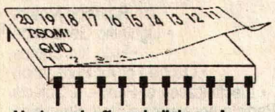

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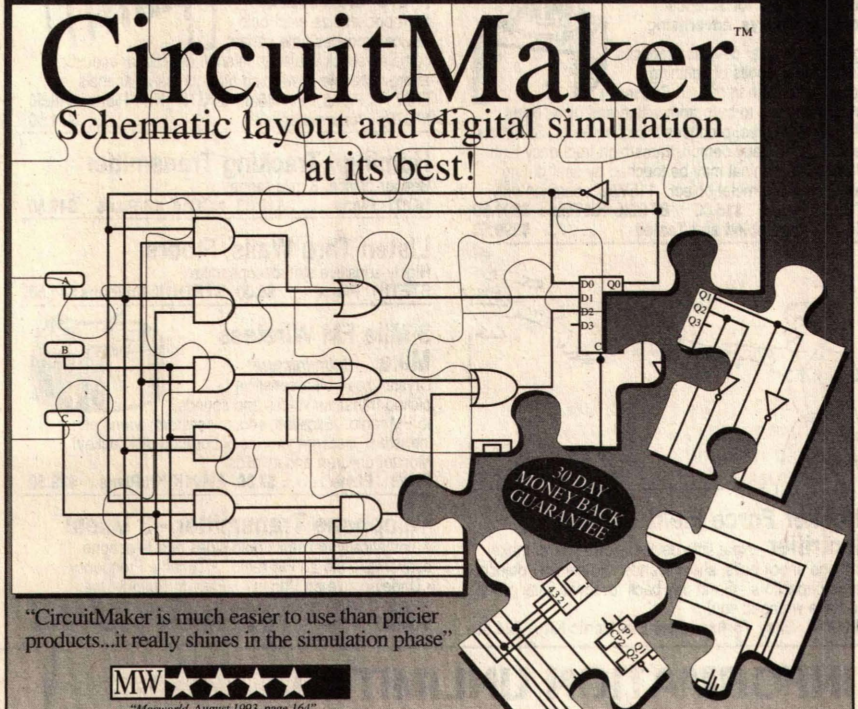

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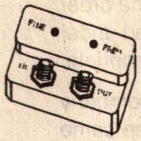

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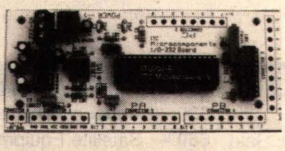

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We cannot bill for classified ads. Payment in full must accompany your order. We do permit repeat ad or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first two words of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $1.25 per word. Minimum charge is $18.75 per ad per insertion (15 words). Any words that you war set in bold or caps are 20¢ each extra. Bold caps are 40¢ eac extra. Indicate bold words by underlining. Words normally writte in all caps and accepted abbreviations are not charged as all-cap words. State abbreviations must be Post Office 2-letter abbrevia tions. A phone number is one word.

CONTENT

All classified advertising in the **Electronic Shopper** is limited electronics items only. All ads are subject to the publisher's a proval. We reserve the right to reject or edit all ads.

DEADLINES

Ads received by our closing date will run in the next issue. F example, ads received by April 1 will appear in the July, 1993 issu that is on sale in June 3. Shopper ads will appear Jan., Mar., Ma etc. No cancellations permitted after the closing date. No co changes can be made after we have typeset your ad. NO R FUNDS, advertising credit only. No phone orders.

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- **130** — Audio-Video-Lasers
- **160** — Business Opportunities
- **190** — Cable TV
- **210** — CB-Scanners
- **240** — Components
- **270** — Computer Equipment Wanted
- **300** — Computer Hardware
- **330** — Computer Software
- **360** — Education
- **390** — FAX
- **420** — Ham Gear For Sale
- **450** — Ham Gear Wanted
- **480** — Miscellaneous Electronics For Sale
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[ ] Check [ ] MasterCharge [ ] Visa ($18.75 minimum credit card order)

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Signature ______________

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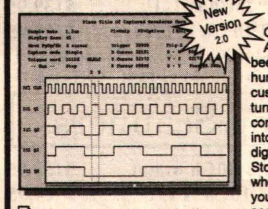

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Requires 286, or higher with EGA or VGA display.

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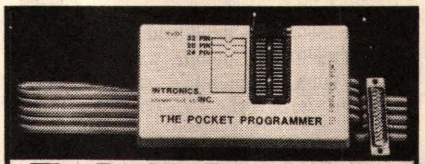

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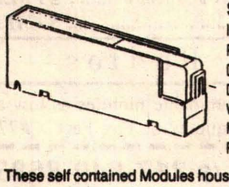

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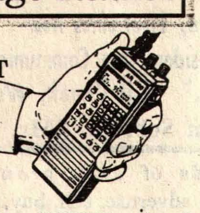

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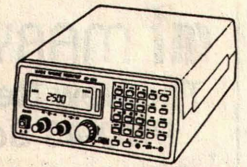

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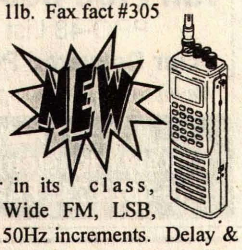

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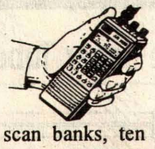

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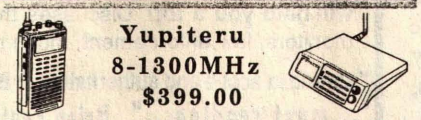

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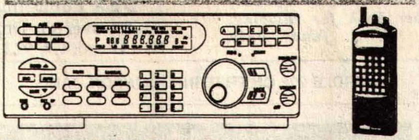

Bearcat 2500XLTA hand held	**$349.95**
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25-1300MHz, 500 ch. in 8500, 400 in 2500. 890 has 200 ch.& 29-956MHz. All cell locked. Features include turbo scan, VFO, search and store, Priority, LCD display, and more. Fax Facts474,475,476

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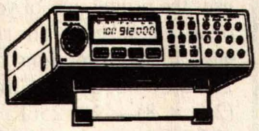

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760XLTM
$219.95
100 Channel
800 MHz

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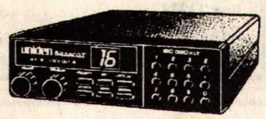

Bearcat
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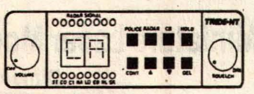
$99.95
16 Channel
10 Band

Compact, digital programmable unit covers 29-54, 136-174, and 406-512MHz. Size: 7 3/8 x 2 1/2 x 15/8. Wt: 2.5lbs. Fax fact #560



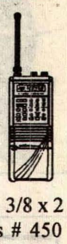
Trident
TR-33WL
$399.00
Scan/CB. X,K,Ka,Wide & Laser

Scans police pre-programmed by state channel *plus* full radar and laser alerts in one small unit. Weather, CB receive & mobile relay. Size: 5 5/8 x 4 7/8 x 1 3/4. Wt: 1.5lbs. Fax fact #580

Shortwave Radios

Sangean ATS-818CS	**$219.95**
Sangean ATS-818	**$184.95**
Sangean ATS-803A	**$169.95**
Sangean ATS-808	**$179.95**
Sangean ATS-606	**$149.95**
Sangean ATS-606P	**$169.95**
Sangean ATS-800	**$89.95**

Hand Held Scanners



Bearcat 200XLTN
$209.95 200 Channels 800 MHz

Ten scan banks plus search. Covers 29-54, 118-174, 406-512 and 806 956MHz (with cell lock). Features scan, search, delay, 10 priorities, mem backup, lockout, WX search, keylock. Includes NiCad & Chrgr. Size: 1 3/8 x 2 11/16 x 7 1/2. Wt. 32 oz. Fax Facts # 450

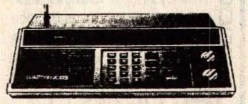
Bearcat 100XLTN 100Ch H/L/U	**$159.95**
Bearcat 70XLTP 20Ch H/L/U	**$139.95**
Bearcat 55XLTR 10 Ch H/L/U	**$ 99.95**

Coverage of above hand helds is: 29-54, 136-174, 406-512 except 100 which also adds 118-136 Air Band. Fax facts #475

Table Top Scanners

Bearcat 855XLTE 50Ch w/800	**$159.95**
Bearcat 142XLM 10Ch H/L/U	**$ 84.95**
Bearcat 147XLJ 16 Ch H/L/U	**$ 89.95**
Bearcat 172XM 20Ch H/L/U/Air	**$124.95**
Bearcat 210 16Ch H/L/U/Air	**$129.95**

Coverage of above units is: 29-54, 136-174, 406-512, plus Air in 172 and 210 and air plus 800MHz in the 855. Fax facts #675



Bearcat
800XLX
$209.95

12 bands and 40 channels with 800MHz and nothing cut out. AC or DC. Fax facts #690

Accessories & Etc.

Mag Mount Mobile Ant MA100	**$ 19.95**
Base Ant. 25-1000MHz AS300	**$ 59.95**
Pre-Amp .1-1500MHz GW2	**$ 89.00**
Downconverter 800 to 400 DC89	**$ 89.00**
Base Discone Ant DA300	**$ 89.00**
External Speaker MS190/opt. amp	**$ 19.95**
Old Scanner Repair, all brands	**$ *CALL***
Extended Warranties	**$ *CALL***
Frequency Info FaxFact/Modem	**$ *FREE***
Frequency Books	**$ *CALL***

2 Way Radios

VHF hi band programmable mobiles as low as $299.95. Call for quotes or Fax Fact #775

Toll Free, 24 Hours! ***800-445-7717*** *Fax Orders* ***800-448-1084*** *Fax Facts* ***317-849-8683***
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International Fax: en *Espanol, en Francais, und auf Deutsch, or just fax in plain English to:* **317-849-8794**

ACE Communications 6975 Hillsdale Court, Indianapolis, IN 46250

Service & Support hours: Mon.-Fri. 9AM to 6PM, Sat. 10-4 EST. Mastercard, Visa, Checks, Approved P.O.'s & COD (add $5.50) & AMEX, Discover. Prices, specifications and availability subject to change. Flat rate ground shipping and handling charge only $5.95 per unit. Express Air only $8.95 , for most units, to most locations. One week trial, no returns accepted two weeks after original receipt without substantial restocking charge. All units carry full factory warranty. Indiana residents add 5 per cent sales tax.

FLY IT! ONLY $8.95

CIRCLE 212 ON FREE INFORMATION CARD

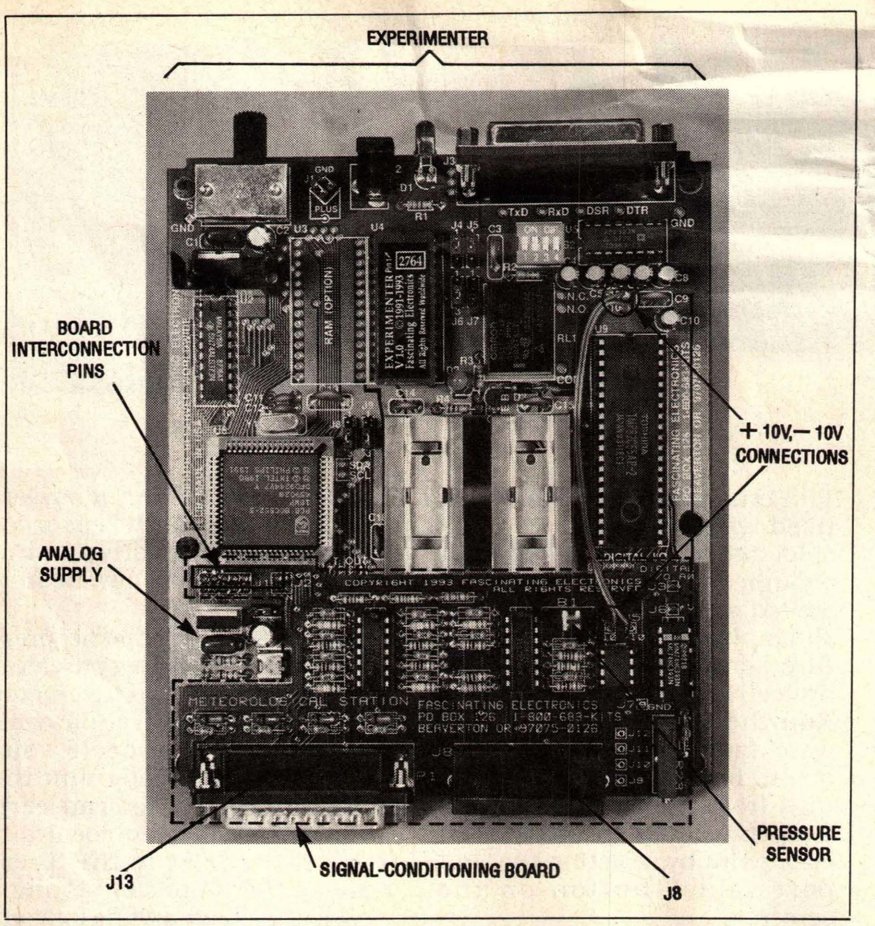


FIG. 6—THE WEATHER BOARD is mounted directly on the Experimenter as a daughterboard. Note the pressure sensor is located on the weather board.

signal-conditioning board also provides connections to pins 1 and 2 of modular jack J8-b if you prefer to use a separate connector for each of the wind instruments.

The R-C filter and pull-up resistor formed by R11 and C8 eliminates contact bounce that can occur when the magnetic switch opens and closes. The resulting filtered signal goes to T_{INO} on the Experimenter. The Experimenter uses the waveform's falling-edge to falling-edge time measurement function (Experimenter command C 0 8) to measure the duration of a half rotation of the wind cups.

The weather station software has a default calibration factor, based on sample anemometers, that converts from the measured time duration to a wind speed. The accuracy of the default calibration factor is high, and no further calibration is usually necessary. However, if you determine a more accurate value for your particular anemometer, you can change the calibration factor in the calibration menu.

- Wind vane. The electrical interface for the wind vane is very simple. Pins 1 and 4 of the wind vane's potentiometer connect from the analog supply to ground through pins 6 and 20 of J13. The two potentiometer wipers, pins 2 and 3, connect to pins 19 and 7 of J13. The wind vane can also be connected to pins 3–6 of modular jack J8-b.

The potentiometer gives the wind vane very good resolution of one degree with no "deadband" in the readings due to the dual-wiper potentiometer. A wind vane offset value can be entered in the software's calibration menu. You can adjust this value to align the wind vane's direction readout with true North, rather than moving the mounting for alignment. If you find that the wind vane display rotates in the opposite way from the actual wind vane, just reverse the order of the four wires going to the potentiometer.

The wind instruments must be located away from obstructions that would block the wind. Although mounting the instruments on top of an eighty-foot tall tree would be ideal, mounting on a five-foot pole in a field away from trees and buildings or on a three-foot pole strapped to a chimney should also be adequate.

CONDITIONING BOARD AND BAROMETER

- **Signal conditioning board and barometer kit—$49.90**

(1) signal conditioning board
(2) TLC2274 op-amps (National Semiconductor) or equivalent
(1) 74HC393 dual counter (Harris Semiconductor) or equivalent
(1) AD621 instrumentation amplifier (Analog Devices)
(1) SCC15A pressure sensor (Sensym)
(1) 20-kilohm multiturn potentiometer
(16) 0.1 μF disk capacitors
(2) 1-megohm, 5%, ¼-watt resistors
(2) 10-kilohm, 5%, ¼-watt resistors
(5) 499-kilohm, 1%, ¼-watt resistors
(7) 100-kilohm, 1%, ¼-watt resistors
(1) 28.0-kilohm, 1%, ¼-watt resistor
(1) 13.7-kilohm, 1%, ¼-watt resistor
(1) 12.7-kilohm, 1%, ¼-watt resistor
(1) 10.0-kilohm, 1%, ¼-watt resistor
(1) 2.87-kilohm, 1%, ¼-watt resistor
(1) 1-kilohm, 1%, ¼-watt resistor
(1) DB-25M connector
(3) triple 6-contact modular jack

- **Bare signal-conditioning PC board only—$19.90**
- **Assembled and tested signal-conditioning board and barometer—$99.90**

Includes:
Signal-conditioning circuitry for all the sensors
Both DB-25 and modular connectors installed
Barometer that requires calibration at your location

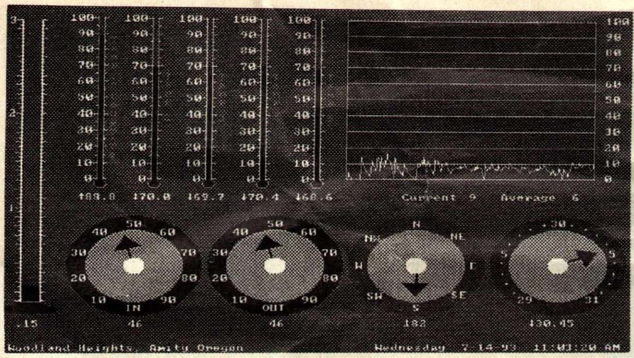
SOFTWARE

- **Professional version software for PC—$39.90**
- **Professional version software for MAC—$49.90**

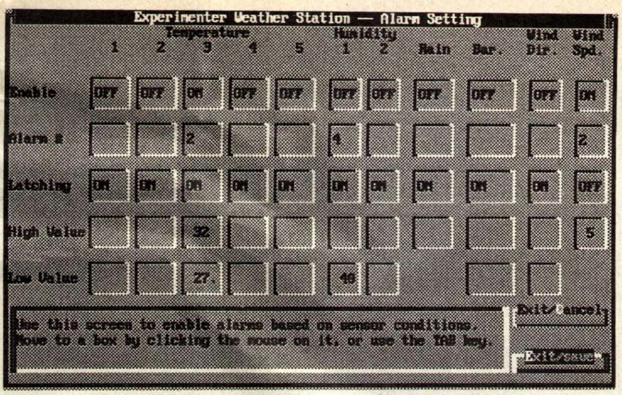
THE EXPERIMENTER

- **Experimenter kit—$149.90**
- **Optional analog supply—$4.90**
- **Assembled and tested Experimenter with analog option—$199.90**

For more information on the Experimenter, see the July and August 1993 issues.



THE MAIN DISPLAY of the weather station.



Experimenter Weather Station — Alarm Setting

	Temperature					Humidity				Wind	Wind
	1	2	3	4	5	1	2	Rain	Bar.	Dir.	Spd.
Enable	OFF	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON
Alarm #			2			4					2
Latching	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	OFF
High Value			32								5
Low Value			27.			40					

Use this screen to enable alarms based on sensor conditions.
Move to a box by clicking the mouse on it, or use the TAB key.

ALARM-SETTING DISPLAY.

If you are not comfortable working on your roof, you might call in a local contractor who installs and services TV antennas, as the mounting problems are very similar. Just be sure to test the wind instruments fully before installing them on the roof!

- Rain gauge. The electrical interface for the rain gauge is identical to that of the anemometer because both use the same type of magnetic switch. The magnetic switch connects to pins 9 and 21 of J13. The signal-conditioning board also provides connections for the rain gauge at modular jack J8-c, pins 1 and 2.

The Experimenter counts pulses on the rain-gauge signal and converts the count into a rainfall reading. The software uses a default calibration factor based on measurement of typical units. To enter a new calibration factor based on your particular rain gauge, start the program and go to the calibration screen. Set the rain gauge in a 1-quart measuring cup under a slowly dribbling faucet. The rain count should slowly increment. When the measuring cup is filled to the 1 quart mark, stop the water. This amount of water is equivalent to 2.3 inches of rain (based on an 8-inch funnel diameter). Divide the count number by 2.3, and the result is the number of counts your rain gauge produces for 1 inch of rain. Select the rain calibration from the software menu and enter the number you just calculated. Your rain gauge is now precisely calibrated.

- Temperature sensor. A 32° Fahrenheit bath provides an ideal temperature reference. Take crushed ice made from distilled water (or snow, if available) and put it in a cup with enough cold distilled water (or melted snow) to make a thick slush. Immerse the temperature sensors, secure in their protective tubing, in the slush. Run the weather station software and select the calibration menu. Import the voltage readings from each sensor at this temperature for the 32°F reference point by selecting the "import value" button on the screen.

To achieve the highest accuracy, perform a calibration at a second temperature point. Put warm water (95 to 100°F) in a thermally insulated container and immerse both the temperature sensors and an accurate thermometer. Enter the thermometer's reading in the temperature calibration menu, and import the voltages measured on each of the temperature sensors. Your temperature sensors will now be fully calibrated.

- Humidity sensor. Verify that the sensor works by checking that the output for the sensor reads roughly 4000 microseconds in the calibration menu. If you exhale deeply on the sensor, the water vapor in your breath should make the reading increase.

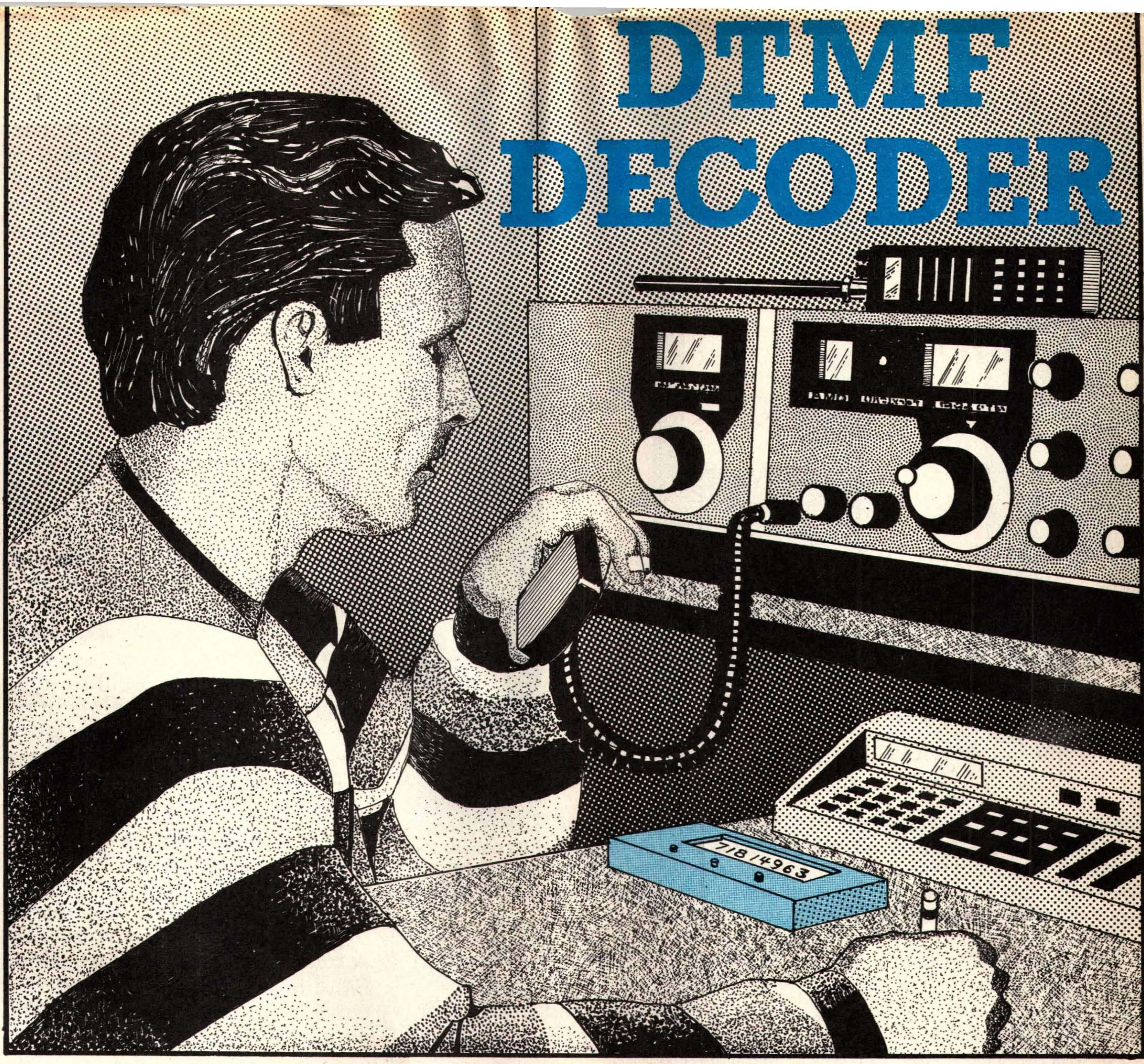
To calibrate the humidity sensors, place them in a closed container with a wet cloth or sponge. Allow the container to sit overnight so that the interior air and humidity sensors can become completely saturated. Go to the calibration screen in the weather station software, and select humidity and import the values from each sensor for 100% relative humidity. The humidity sensors will now be fully calibrated.

- Barometer. Barometric pressure varies with respect to elevation. Multiturn potentiometer R13 is used for elevation compensation. To calibrate your sensor, you must determine the local air pressure. You can learn this by calling your local airport. Pilots refer to this pressure as the "altimeter setting."

Once you have a value for your present local barometric pressure, start the program and go to the calibration menu. Find the nearest pressure and calibration value from Table 1 and adjust R13 to set the voltage reading to the value nearest the current pressure. You will not need to adjust R13 again, as all further barometer calibration will be done in software. Select the "baro" calibration button. That will bring up a menu that allows you to specify the current pressure, and transfer the voltage reading corresponding to that pressure. This provides one calibration point.

To adjust for your pressure sensor's sensitivity, the barometer must be calibrated at a second pressure. When the barometric pressure has changed significantly, you can provide the second calibration point. Determine the current local pressure, enter the calibration menu and "baro" function, type in the current pressure for the second point, and import the current voltage reading. The barometer is now calibrated. Ω

DTMF DECODER



Scanner users: here's an inexpensive way to decode DTMF tones that you hear.

FRANK HAMPSHIRE

HAVE YOU EVER BEEN CURIOUS about the dual-tone multifrequency (DTMF) tones heard on your scanner or amateur-band receiver? The circuit discussed here will decode DTMF tones and display them on a liquid crystal display, so that you can get a better understanding of the action on the radio bands.

The unit has a memory capacity of 64 digits, yet the cost of building this project is one-third to one-half of comparable commercially available instruments.

Hardware

The circuit consists of three major components: a microcontroller, a DTMF decoder IC, and an LCD display module. The microcontroller, a Motorola 68705P3, is packaged in a 28-pin DIP, and contains 1804 bytes of EPROM, 112 bytes of RAM, 2 bi-directional 8-bit ports, and a bi-directional 4-bit port. Software for the microcontroller will be posted on the *Electronics Now BBS*. The 68705 microcontroller was discussed in the September and October 1989 issues of **Radio-Electronics**.

The DTMF receiver/decoder, a Silicon Systems 75T-202, requires a 5-volt power supply and a 3.579545-MHz colorburst crystal. It will decode all 16 Touch-Tone frequency pairs. The display, an Optrex DMC16101A sixteen-by-one LCD module, was covered in the June and July 1990 issues of **Radio-Electronics**. The module makes it very easy to display alphanumeric characters because it has a built-in controller that handles all conversion details.

How it works

The schematic for the DTMF decoder is shown in Fig. 1. Software configures all 8 bits of Port A (pins 20–27) of the microcontroller as outputs, which drive D0–D7 of the LCD module. Port B of the microcontroller

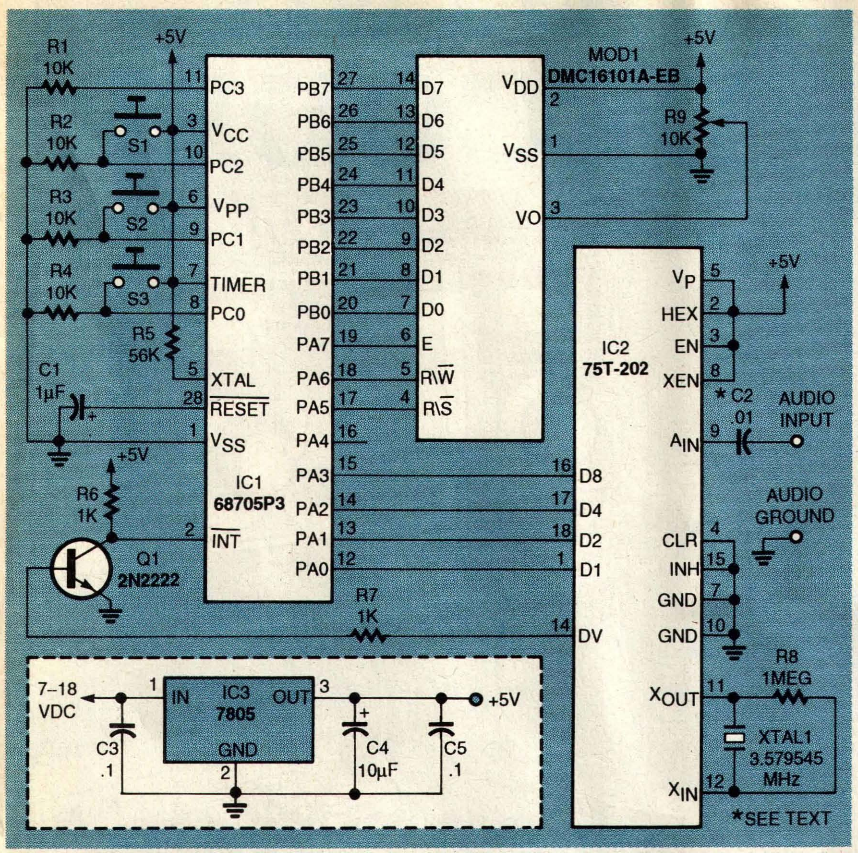

R1
10K
R2
10K
R3
10K
R4
10K
S1
S2
S3
R5
56K
C1
1µF
+5V
R6
1K
Q1
2N2222
PC3
V_{CC}
PC2
V_{PP}
PC1
TIMER
PC0
XTAL
RESET
V_{SS}
IC1
68705P3
INT
PB7
PB6
PB5
PB4
PB3
PB2
PB1
PB0
PA7
PA6
PA5
PA4
PA3
PA2
PA1
PA0
MOD1
DMC16101A-EB
D7
D6
D5
D4
D3
D2
D1
D0
E
R\W
R\S
V_{DD}
V_{SS}
VO
R9
10K
IC2
75T-202
V_P
HEX
EN
XEN
A_{IN}
D8
D4
D2
D1
CLR
INH
GND
GND
DV
X_{OUT}
X_{IN}
*C2
.01
AUDIO INPUT
AUDIO GROUND
R7
1K
R8
1MEG
XTAL1
3.579545
MHz
*SEE TEXT
7–18
VDC
IC3
7805
IN
OUT
GND
C3
.1
C4
10µF
C5
.1

FIG. 1—DTMF DECODER SCHEMATIC. Port A of the microcontroller sends data to the LCD module. Bits 5–7 of Port B are the control signals for the LCD module. Bits 0–3 of Port B accept data from the DTMF decoder, and bit 4 is unused. Bits 0–2 of Port C are inputs that read the switches (S1–S3), and bit 3 is unused.

has bits 5–7 configured as outputs that are the control signals for the LCD module. Bits 0–3 of Port B are inputs that accept data from the DTMF receiver/decoder IC, and bit 4 is unused in this project. Bits 0–2 of Port C are inputs that read the switches (S1–S3), and bit 3 of Port C is unused.

Within 40 milliseconds after receiving a valid tone pair, the decoded data (in 4-bit format) is latched onto the DTMF receiver/decoder's output lines and a DATA VALID (DV) signal is generated by the receiver at pin 14 to signal that data is ready to be picked up. Because the microcontroller's INTERRUPT input (INT) is active-low, the DV output from IC2 is inverted by Q1 for proper operation.

Upon receiving the INT signal, the microcontroller suspends other operations and jumps to a routine that deals with the interrupt. This routine accepts data from the receiver, looks up the corresponding character, and outputs it to the display, along with display-control codes. Approximately five seconds after the last valid tone is received, a blank space is sent to the display for aesthetic purposes. After 16 characters have been sent to the display, the microcontroller forces the display to scroll from right to left.

The microcontroller contains a 64-character memory, which can be displayed as four screens of 16 characters. Pressing S1 scrolls the pages. If more than 64 characters have been received, the characters are shifted out of memory.

Two other switch functions

PARTS LIST

All resistors are ¼-watt, 10%
R1–R4—10,000 ohms
R5—56,000 ohms
R6, R7—1000 ohms
R8—1 megohm
R9—10,000 ohms, PC-mount potentiometer

Capacitors
C1—1 µF, 35 volts, electrolytic
C2—0.01 µF, Mylar (see text)

Semiconductors
IC1—Motorola 68705P3 microcontroller (preprogrammed)
IC2—Silicon Systems 75T-202 DTMF receiver
Q1—2N2222 NPN transistor

Other components
MOD1—Optrex DMC16101A-EB 16 × 1 LCD module (available from Novus, 919-460-7771)
XTAL1—3.579545-MHz colorburst crystal
S1–S3—SPST pushbutton switch

Miscellaneous: PC board, suitable case, screws, spacers, wire, header pins

Power supply parts
IC3—7805 5-volt regulator
C3—0.1 µF disk or Mylar capacitor
C4—10 µF, 16 volts, tantalum capacitor
C5—0.1 µF, disk or polyester capacitor
9-volt DC transformer
TO-220 heatsink for the 7805 regulator

Telephone interface parts
T1—600-ohm:600-ohm hybrid transformer
MOV1—Metal-oxide varistor
C6—0.1 µF, 200 volts, metal-film capacitor

Note: The following items are available from ElectroMagix, 511 Battleground Road, Chesnee, SC 29323 (803) 461-4664:

- **A kit of parts including a PC board, display module, and commented source code on disk (does not include case, switches, phone interface, or power supply)—$95.00 + $2.50 S&H. SC residents please add appropriate sales tax.**

- **The author also has a commercial version of this instrument that includes RS-232C, a printer port, and real-time clock for automated logging, complete with case and power supply. If you are interested, contact the author at the address or phone number listed. If you leave a message, the author will return your call, collect. He can also be reached via WI8H @ KI4FL.SC.**

are included: S2 clears the display and S3 clears the memory. Resistors R1 through R4 are pull-down resistors for the switches. When any switch functions are used, the microcontroller disables the interrupt and refuses to accept any data from the 75T-202. The circuit must then be returned to a "ready" condition for further use.

The circuit requires a 5-volt DC power supply at approximately 125 milliamperes to operate. If you can't get the regulated 5 volts from some other circuit, such as your scanner, or don't want to open it up, the power supply shown in the dashed lines in Fig. 1 can be used.

The DTMF receiver/decoder chip (IC2) is sensitive to DC-biased signals, and if your audio source has a DC bias approaching 5 volts, capacitor C2 must be used to isolate the decoder. If your equipment has no DC bias on its audio output, C2 should be replaced with a jumper wire. The omission of C2 will noticeably increase the decoder's sensitivity. The 75T-202 has an input impedance of 100 kilohms, so loading of the audio line is negligible.

Note that the circuit is sensitive to over-voltage conditions, so a properly regulated supply is important. The author found a regulated 5-volt source inside his scanner, so he added a jack to the scanner that would supply 5 volts and audio to the DTMF decoder. If you can't or don't want to tap power from your scanner, build the power supply shown in Fig. 1 mentioned earlier. One advantage of using a separate power supply is that it allows the decoder to be transferred between scanners more easily.

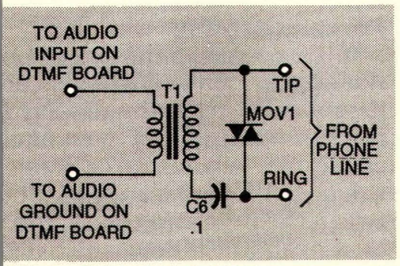


FIG. 2—THIS ISOLATION transformer is necessary to connect the DTMF decoder to a phone line.

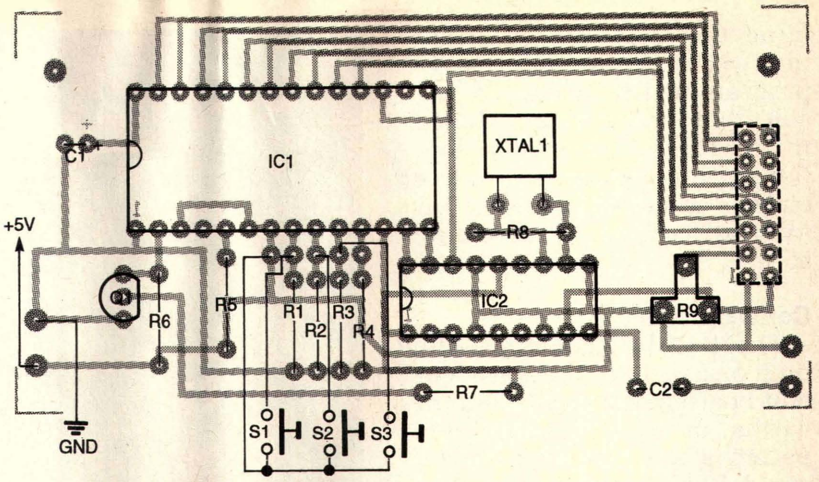
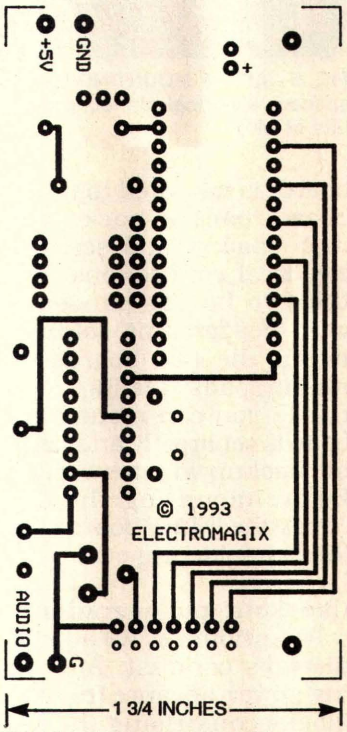
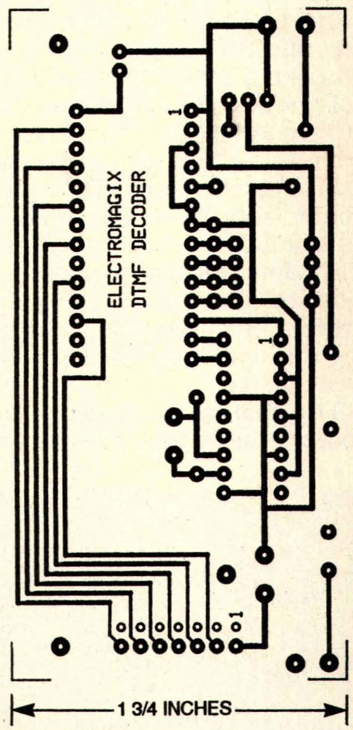


FIG. 3—PARTS-PLACEMENT DIAGRAM. Sockets for IC1 and IC2 are recommended.



DTMF BOARD component side.



DTMF BOARD solder side.

As shown in Fig. 1, the DTMF decoder can accept an audio input—with or without a DC bias—directly from a pair of speaker terminals, such as those of a scanner. To input audio from a telephone line, the isolation transformer circuit shown in Fig. 2 will be necessary to match signal levels properly. If the circuit is constructed as shown, there won't be enough DC load on the phone line to cause an off-hook condition, yet you will be able to continuously monitor Touch-Tone calls made on your telephone line.

Software

The operating software is an assembly-language program contained in the microcontroller's EPROM. Although the software listing is too long to print here, the commented source code is available on the *Electronics Now BBS* (516-293-2283, 1200/2400, 8N1) as filename DTMF.TXT. The file must be assembled and programmed into the microcontroller's EPROM; if you do not have the facilities for assembling the code and programming the EPROM, a preprogrammed EPROM is available from the source mentioned in the Parts List. A disk containing the commented source code is included with the kit available from that same source.

Construction

The DTMF decoder can be built on a piece of perforated circuit board using point-to-point wiring, or on a PC board. Foil patterns are provided here if you'd like to make your own board, or you can purchase one from the source given in the Parts List. A parts-placement diagram is shown in Fig. 3.

Sockets are recommended for IC1 and IC2. Those ICs, and the LCD module, are ESD-sensitive devices, so handling precautions must be taken. The crystal holder should be mounted on its side and secured to the board with double-sided tape to provide mechanical stability and prevent the crystal from shorting any traces on the PC board (see Fig. 4).

The display module, which comes preassembled on its own board, is mounted to the DTMF board, back-to-back, with ¼-inch spacers and screws. The electrical connections between the two boards can be made with header pins soldered between the two boards at the mating pads (see Fig. 5). Alternately, you can mount the two boards separately and run flexible hookup wire between them. Before mounting the display, check the DTMF board carefully for any soldering errors.

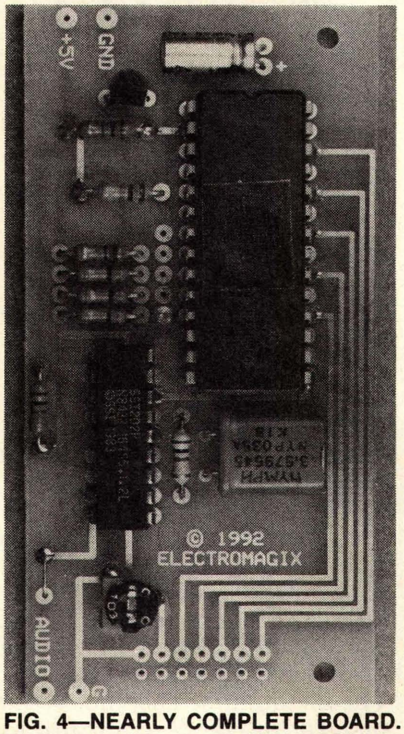


FIG. 4—NEARLY COMPLETE BOARD. Notice how the crystal holder is bent on its side and secured to the board with double-sided tape.

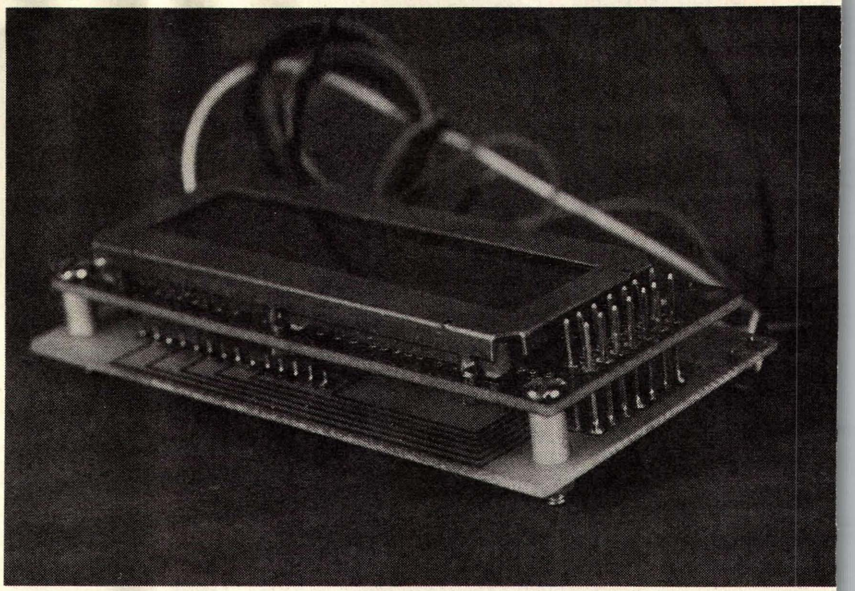


FIG. 5—AFTER MOUNTING the display module to the DTMF board with screws an spacers, electrical connections between the two boards are made with header pins o bits of wire.

Checkout and operation

Potentiometer R9 adjusts the display's contrast. After applying power, advance R9 until the blocks comprising the display are visible, and then reduce R9 for the desired contrast. Remove power for several seconds and then reapply power. The display should show "*ELECTROMAGIX*" for several seconds and then clear, displaying just a cursor.

Attach a wire from the high side of your scanner's speaker to the audio input on the DTMF board, and one from the ground side of the speaker to audio ground on the DTMF board. Tune to a frequency with DTMF traffic, and you should see the digits displayed as you hear them. A Touch-Tone pad on a 2-meter band transmitter would be invaluable for checkout.

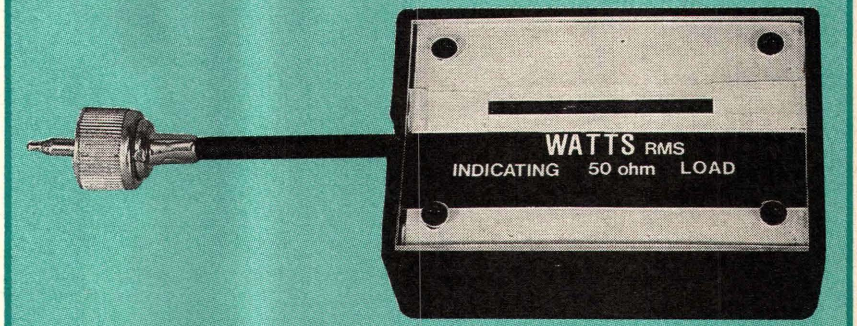
Note that performance decreases rapidly as the signal-to noise ratio decreases. Fo monitoring weak signals, a outboard passband filter i needed. Many inexpensiv scanners have such poor audi quality that they won't pas Touch-Tone pairs without distortion, and the distorted tone can't be decoded. Cordless telephones are difficult to decod unless they emit a strong signal. For a successful decode, tone pair must be present for 4 milliseconds with a 40-millisecond pause between digits.

Pressing switch S2 clears th display, and S3 clears the memory and displays "ME CLEARED!" Switch S1 will redisplay the memory as fou screens—one screen for eac button press—of 16 characters pressing S1 a fifth time display "*READY*" and returns the display to normal operation.

Troubleshooting

If the power-up message doe not appear, make sure R9 is adjusted properly. If the display i not functioning, the most likel cause is a wiring error. Chec the board for solder bridges between the pins and traces. Pin of IC1 should show a 1-megahertz sawtooth waveform tha verifies the operation of the microcontroller.

BUILD A NOVEL LCD AMMETER AND RF POWER METER



Make useful and inexpensive ammeters, power meters, or temperature indicators from Duracell's Copper Top Testers

BRIAN MCKEAN.

DURACELL INC. REVOLUTIONIZED the marketing of consumer electronics batteries with its *Copper Top Tester*, a disposable instrument for measuring power cell charge that is built into the blister packages for its products. The tester consists of a thin-film resistor combined with a liquid-crystal bargraph display. This article shows how the tester can be recycled to make low-cost ammeters, wattmeters or transition temperature sensors.

The tester provides a reliable indication of the charge on a power cell or battery in seconds. All you do is position positive and negative terminals of the cell to match the corresponding contact pads of the tester, insert the cell between the contact pads, and squeeze the pads with thumb and forefinger down on the cell terminals.

After a few seconds you'll see a colored band gradually rise on the face of the tester. When it stops rising, observe the height of the column: If the colored band does not rise above the red "replace" zone, (or is only slightly above it), dispose of the cell. However, if the stripe stops near the top of the column, you can be assured that you have have a fresh, reliable cell.

The tester is an attractive feature on the product package, especially for those people who buy lots of disposable cells and do not own a separate battery tester—which means most of the population. Before discussing the practical instruments that you can make from a recycled *Copper Top Tester*, lets find out how it works.

How it works

The tester is an assembly on a thin plastic substrate of a tapered thin-film resistor back-to-back with a colored stripe coated with a photochromic liquid-crystal emulsion. Both sides of the tester are shown in Fig. 1.

The apparent rising color band or column is really the result of a progressive state change of the heat-sensitive liquid-crystal film. The optical density of the liquid-crystal film changes at a transition temperature of 43°C (109.4°F). The liquid crystal is opaque below this threshold and tranparent above it. As the heat migrates across the plastic substrate, a gradual transition from opaque to transparent occurs, slowly revealing the underlying colored stripe.

When a cell is clamped between the tester's conductive pads, current flows in the tapered thin-film resistor, raising its temperature in accordance with the power law.

Different versions

The patented tester (Duracell Inc. No. 4723656) is produced in different versions to test most standard alkaline cells–AA, C, and D, for example. The deposition of resistive film is approximately 0.001-inch thick. As shown in Fig. 1, it is about 1-$^{11}/_{16}$-inch long, tapered from $^{3}/_{16}$-inch at one end to $^{1}/_{16}$-inch at the other end.

The resistance values of the element are about 6 ohms for the AA and C cell tester and 4 ohms for D cells. The resistive wedge is terminated at both ends by conductive-film pads that act as terminals. Although more conductive than the resistive elements, the pads add nearly 1 ohm to the value of the resistive element if the measurement is made from the extreme ends of the pads.

For example, the resistance of a D-cell tester element taken across both ends is about 3.7 ohms. But if the measurement

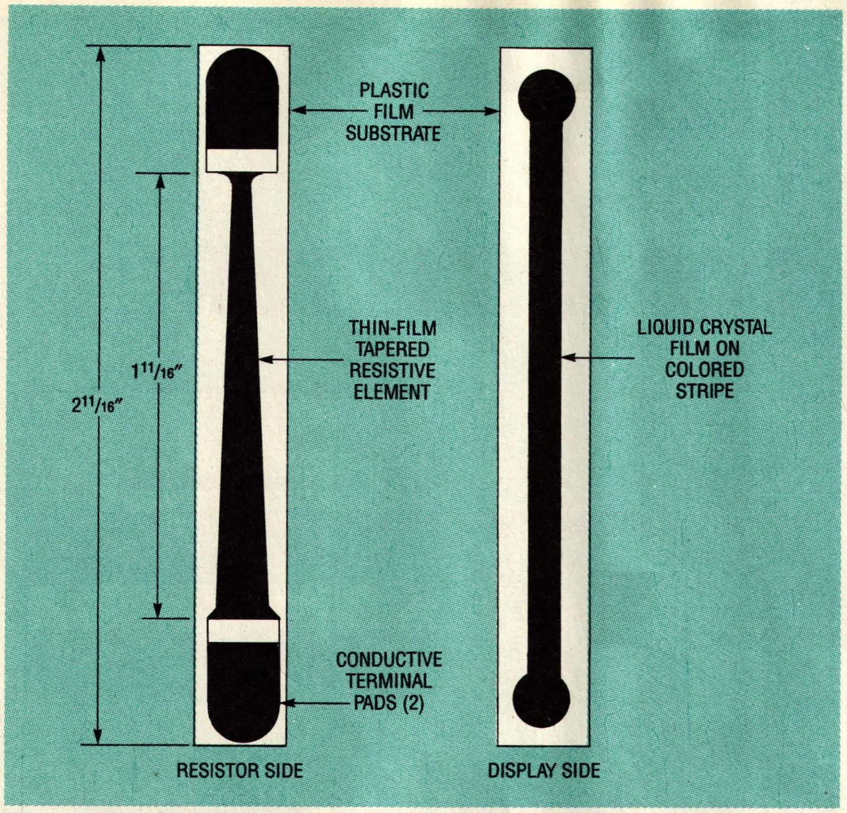

2 11/16"
1 11/16"
PLASTIC FILM SUBSTRATE
THIN-FILM TAPERED RESISTIVE ELEMENT
CONDUCTIVE TERMINAL PADS (2)
LIQUID CRYSTAL FILM ON COLORED STRIPE
RESISTOR SIDE
DISPLAY SIDE

FIG. 1—DURACELL'S COPPER TOP TESTER: Resistive element side (left) and liquid-crystal thermochromic display side (right).

is taken from the ends of the pads, the overall resistance is about 4.6 ohms.

The heating produced by the element is proportional to its resistance and the square of the applied voltage. The tapered element linearizes the liquid-crystal display. As in any thin-film resistor, the resistance at the wide part of the taper is less than it is in the narrow part. As a result, the narrow region dissipates more power than the wide region. This means that a weak cell, which delivers less current, can't heat up the wide region enough for the the liquid-crystal film to reach its transition temperature.

The display element is a coating of thermochromic liquid-crystal emulsion 0.001-inch thick by 3/32-inch wide.

The tester is bonded to the inside of the clear plastic blister package with a welt over the liquid crystal bargraph to protect it during manufacture and use. This cover reduces the sensitivity of the element to environmental temperature changes and prevents it from contacting hot objects directly.

Recycling the tester

The tester can be removed from the bubble pack by carefully peeling it off. Removal will probably damage the printed legends on the package, but they are not important in the recycled applications. You will want to calibrate any devices you make from the testers and then mark the display face of the tester with graduations that are appropriate for its application. You might also want to add appropriate numbers to match those graduations.

To obtain the most accuracy from any instruments you make from these testers, the instrument should be calibrated only after the tester is installed in its final package so that it will be stabilized in its normal thermal environment.

A suggested method for remounting the tester on a rigid substrate for experiments or making instruments is shown in Fig. 2. The conductive contact pads on each tester are coated plastic, so they cannot be soldered. However, adequate electrical contact can be made with brass or bronze leaf or coil springs. Copper or brass screws, washers and nuts can also be used to make satisfactory electrical connections.

Figure 2 shows how small coil springs can be used as contacts. Pierce the centers of the pads with a pin and twist the springs into the holes. The springs act as connectors for the tester, and permit it to be mounted to a rigid substrate. The free ends of the spring can be straightened to form leads which can be soldered to a suitable rigid conductor, such as blank circuit-board material.

If you use this method straighten the spring ends to shapes that permit them to be soldered to a conductive surface before twisting the springs into the tester's terminal pads. When soldering the ends of the spring to the conductive surface, hold them with metal tweezers or a folded copper strip to conduct away heat that would flow up the spring and melt the plastic pads.

In this mounting method, the copper cladding was removed from the region on the strip between the two terminals to provide electrical isolation. A thin strip of foamed plastic about 1/1 -inch thick provides suitable thermal insulation.

Alternatively, you could use small copper or brass screws and nuts with a stack of small brass washers under the terminals at each end to provide the necessary 1/16-inch tester stand off distance.

Building an ammeter

The tester can be recycled as the sensor and display for a compact AC or DC ammeter with a useful operating range of 100 to 400 milliamperes. One possible configuration is that shown in Fig. 2.

Figures 3 and 4 are normalized voltage vs. current curves obtained from salvaged testers. They will permit you to calibrate any ammeters you build. Figure 3 was plotted from 5-ohm resistive elements taken from AA and C cell testers, and Fig. 4 was plotted from 6.7-ohm elements taken from D-cell testers. These graphs also correlat

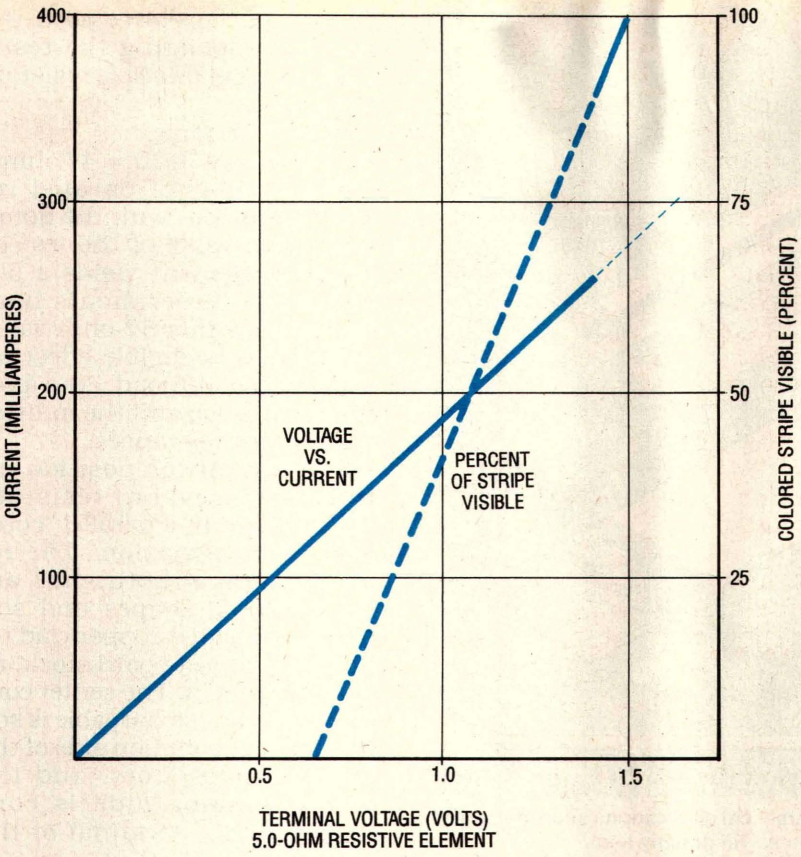


FIG. 2—CURRENT VS. VOLTAGE and voltage vs. visible stripe graph for an AA cell tester (5-ohm resistive element).

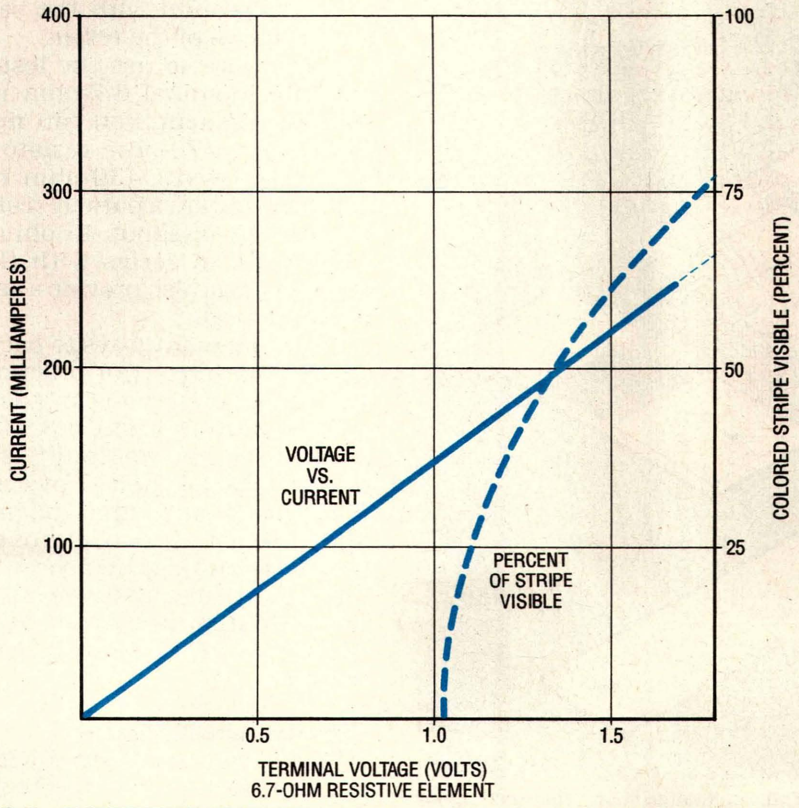


FIG. 3—CURRENT VS. VOLTAGE and voltage vs. visible stripe graph for a D cell tester (6.7-ohm resistive element).

the apparent height of the color bar with applied voltage.

An unmodified tester will not respond to current less than 100 milliamperes. However, the upper range of the ammeter can be extended by connecting a suitable shunt resistor across the tester.

An ammeter made from a tester will not be a precision instrument, but with careful calibration, a reading resolution of +25% full scale can be obtained. Calibration points can be made with pen and ink and clear numbers can be transferred with decals or with artist's transfer sheets.

Flexible insulated leads terminated with miniature alligator clips can be soldered or clipped to the conducting pads on the tester substrate. Small plastic boxes with hinged covers can become cases for the miniature ammeters.

RF dummy load

The tester-substrate assembly shown in Fig. 2 can be adapted to form an indicating radio-frequency dummy load as shown in Fig. 5. The tester actually measures the power dissipated by a resistive element, so it can measure root mean square (rms) alternating current power as well as direct current power. Because the resistive element is a film, it has low equivalent inductance and capacitance; this characteristic makes it acceptable for measuring radio frequencies.

Figure 5 shows a concept for building a low-power (less than 8-watt) 50-ohm load. The circuit can be calibrated with either a DC or low-frequency AC source. The connector installed should match the socket on the intended radio-frequency source or sources.

The resistive load is placed in series with the tester's resistive element so that their sum equals approximately 50 ohms. A practical approach is to parallel ten standard 1-watt, 470-ohm, carbon composition resistors. They are capable of withstanding up to 8 watts of input power, and they provide an approximate resistance of 47

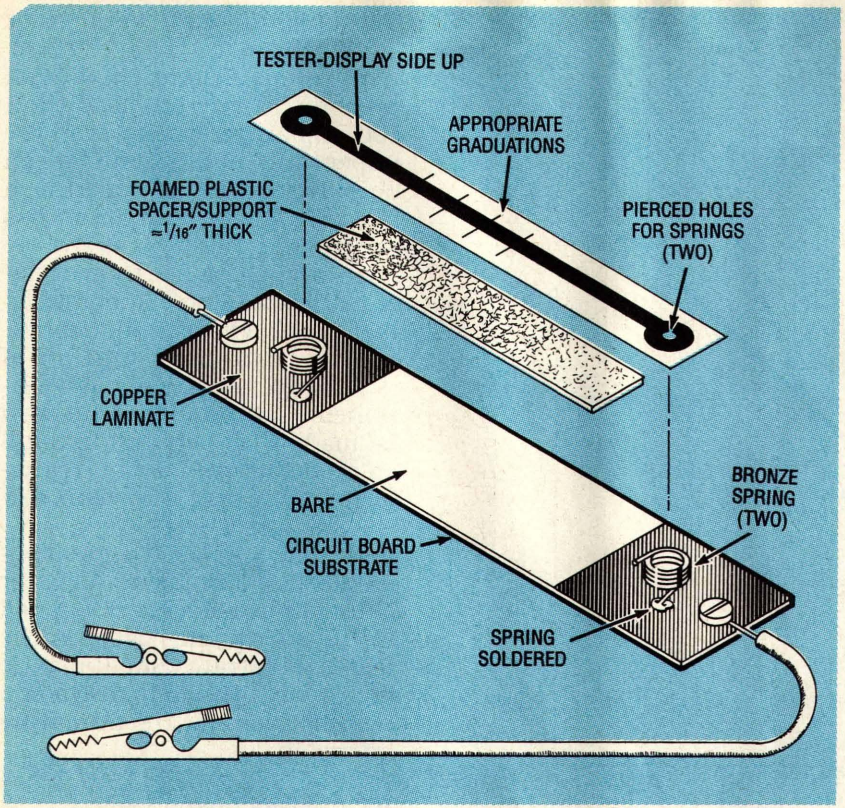

TESTER-DISPLAY SIDE UP
APPROPRIATE GRADUATIONS
FOAMED PLASTIC SPACER/SUPPORT ≈1/16" THICK
PIERCED HOLES FOR SPRINGS (TWO)
COPPER LAMINATE
BARE
CIRCUIT BOARD SUBSTRATE
BRONZE SPRING (TWO)
SPRING SOLDERED

FIG. 4—ONE WAY TO MOUNT THE TESTER for practical applications such making an ammeter (shown) or as the indicating element in an RF dummy load.

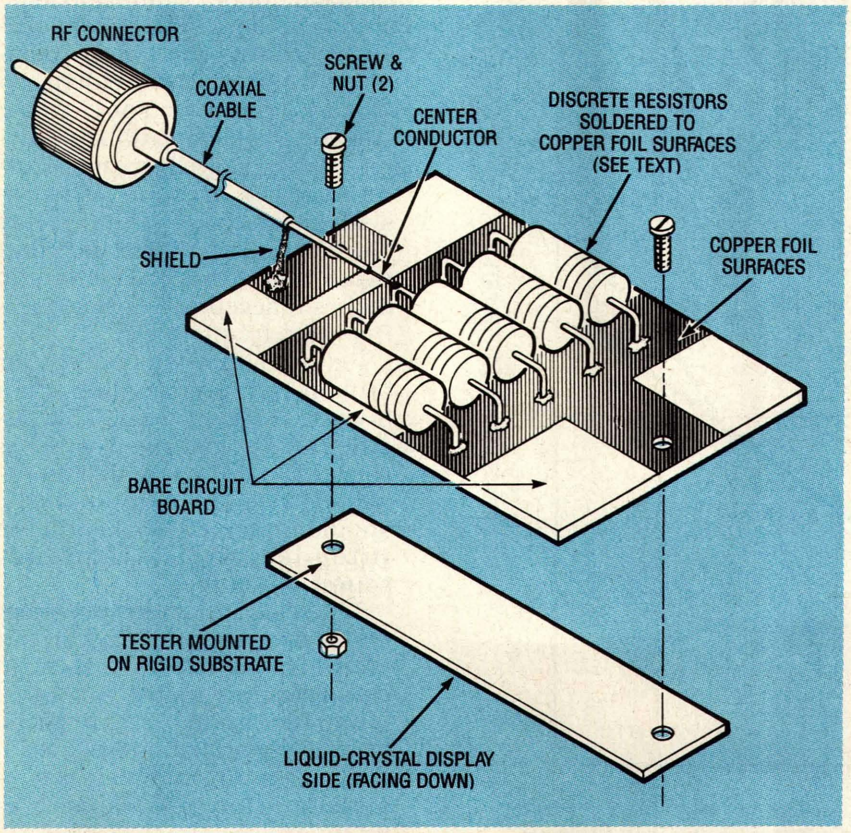

RF CONNECTOR
COAXIAL CABLE
SCREW & NUT (2)
CENTER CONDUCTOR
DISCRETE RESISTORS SOLDERED TO COPPER FOIL SURFACES (SEE TEXT)
COPPER FOIL SURFACES
SHIELD
BARE CIRCUIT BOARD
TESTER MOUNTED ON RIGID SUBSTRATE
LIQUID-CRYSTAL DISPLAY SIDE (FACING DOWN)

FIG. 5—AN INDICATING 50-OHM RF DUMMY-LOAD wattmeter made from the tester. One-watt resistors are connected in parallel to provide approximately 50-ohms resistance and be able to dissipate up to 8 watts.

ohms in accordance with the rule for calculating the resistance value of multiple resistors in parallel.

In this example:
$R_T = \frac{1}{10}R = 470/10 = 47$ ohms.

The cluster of parallel resistors in series with the nominal 5-ohm value of the tester's resistive element yields a 52-ohm load. Experiments have shown that this 52-ohm value will have a negligible effect on the VSWR of the load, even after taking into account the individual resistor tolerances.

The carbon composition (or thick-film carbon) resistors were ganged in a parallel "cordwood" configuration. The resistor leads at both ends are bent into "L"shapes and soldered to isolated copper-clad regions on circuit board stock, as shown in Fig. 5. The center conductor of the coaxial cable is soldered to the common side of the cluster of resistors, and the other common side is connected to the terminal of the tester.

The cable shielding is soldered to a separate isolated copper-clad pad that forms a common ground with the second terminal of the tester.

If you want to use the tester with the nominal 6.7-ohm resistance element, you can mix five 1-watt, 470-ohm resistors with five 1-watt, 430-ohm resistors to obtain a parallel resistance value of about 45 ohms. This value in series with the 6.7-ohms will also provide a satisfactory load.

There are many ways to package the wattmeter for practical use. For example you can package it in a small plastic box with a cover that has a cutout to admit the coaxial cable. However, it is recommended that the parallel resistors and exposed length of coaxial center conductor be shielded with metal foil or screen to prevent the escape of unwanted RF emissions from the load.

Temperature indicator

The tester can be used without electrical connections to indicate the transition tempera-

Continued on page 63

100-WATT DUMMY LOAD

Build this low-cost, 50-ohm amateur radio dummy antenna; it can dissipate 100 watts in the 160 to 10 meter bands.

LINTON G. ROBERTSON KJ6EF

THE *DUMMY ANTENNA* OR *DUMMY load* described here will substitute for "the real thing" when you want to tune or test a transmitter "off-the-air" and prevent the radiation of interference. This 50-ohm load will dissipate up to 100 watts in the 160- to 10-meter amateur bands.

The term "dummy" as in dummy antenna has its origins in the word "dumb," a belittling term for a person unable to talk. However, it evolved into the word dummy, which means an imitation or substitute for the real thing, as in a ventriloquist's large puppet. In radio frequency practice, it is a kind of "black hole" for incoming radio signals; the energy goes in, but never comes back out again.

What is a dummy antenna? It is really a resistor (or group of resistors) matched to the characteristic impedance of the feed line, and it has a power-dissipation rating at least as great as the transmitter's output power. An important requirement is that it have no inductive component which could make it frequency-sensitive. It should provide a voltage standing wave ratio (VSWR) as close as possible to 1.0.

A dummy antenna can also be a useful tool for testing receivers for internally generated noise. This test can be performed when the receiver is effectively shielded from any external interference that could enter its antenna terminals. These tests are usually carried out in metal-screened enclosures called, appropriately enough, *screen rooms.*

The design of a dummy antenna design will depend on the transmitter's operating frequency and power. For low-power cirizen band or or marine-band radio transmitters, the dummy antenna is typically a small, machined cylinder that includes both a coaxial cable receptacle and resistor. The feed-cable plug is disconnected from the antenna and plugged into the load receptacle. A factory-made unit of this kind could cost up to $50.

At microwave frequencies, a dummy antenna can be a waveguide section that includes graphited sand which acts as the resistor. If transmitter output power is to be determined, the waveguide section will include a *water load* that acts as a calorimeter. Power dissipation can be calculated from the increase in water temperature.

Build your own

One way to learn more about dummy antennas—and at the same time save money—is to make your own. The dummy antenna described here is easy to make from low-cost, readily available parts, and you can save a few dollars over the price of even the lowest cost store-bought unit.

To build this dummy antenna, you will need eight 100-ohm, 3-watt carbon resistors, an SO-239 UHF coaxial panel receptacle, a one-gallon paint can, and some brass strips. The resistors and receptacle can be obtained from mail-order houses or most electronics stores, and the new, clean gallon container can be obtained from a paint store. (They are stocked for custom-mixed paint.)

Figure 1 is a cutaway view of the completed dummy antenna. Note that the resistors are arranged in a series-parallel network formed by soldering them to parallel strips of sheet brass. The strips are ½-inch wide, 20- to 30-gauge sheet brass, obtainable precut in lengths of two feet or more from many building supply and hardware stores. The flat strip form reduces possible effective inductance, and brass is stiffer than copper of comparable thickess. It also has a lower resistance than iron or steel.

If molded carbon-composition units are not available, carbon thick-film resistors can be substituted. The calculated effective value of the network is 50 ohms, slightly less than the 52-ohm characteristic of the feed line. However, if one considers the tolerances of actual resistors, a measured value would not be precisely 50 ohms. Nevertheless, if the network is built as specifed here, the effect on VSWR should be negligible.

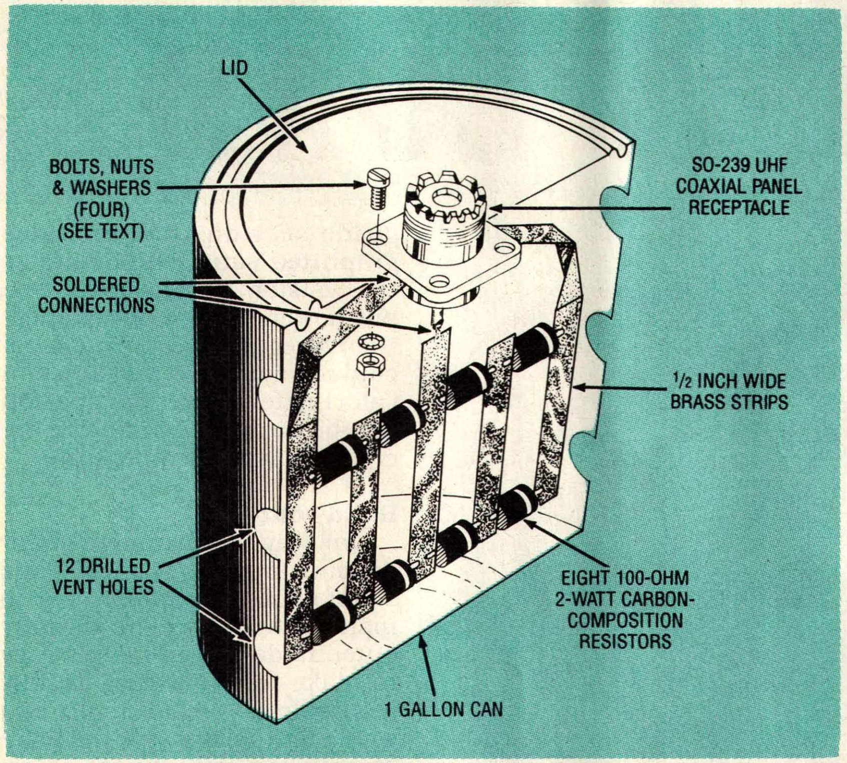
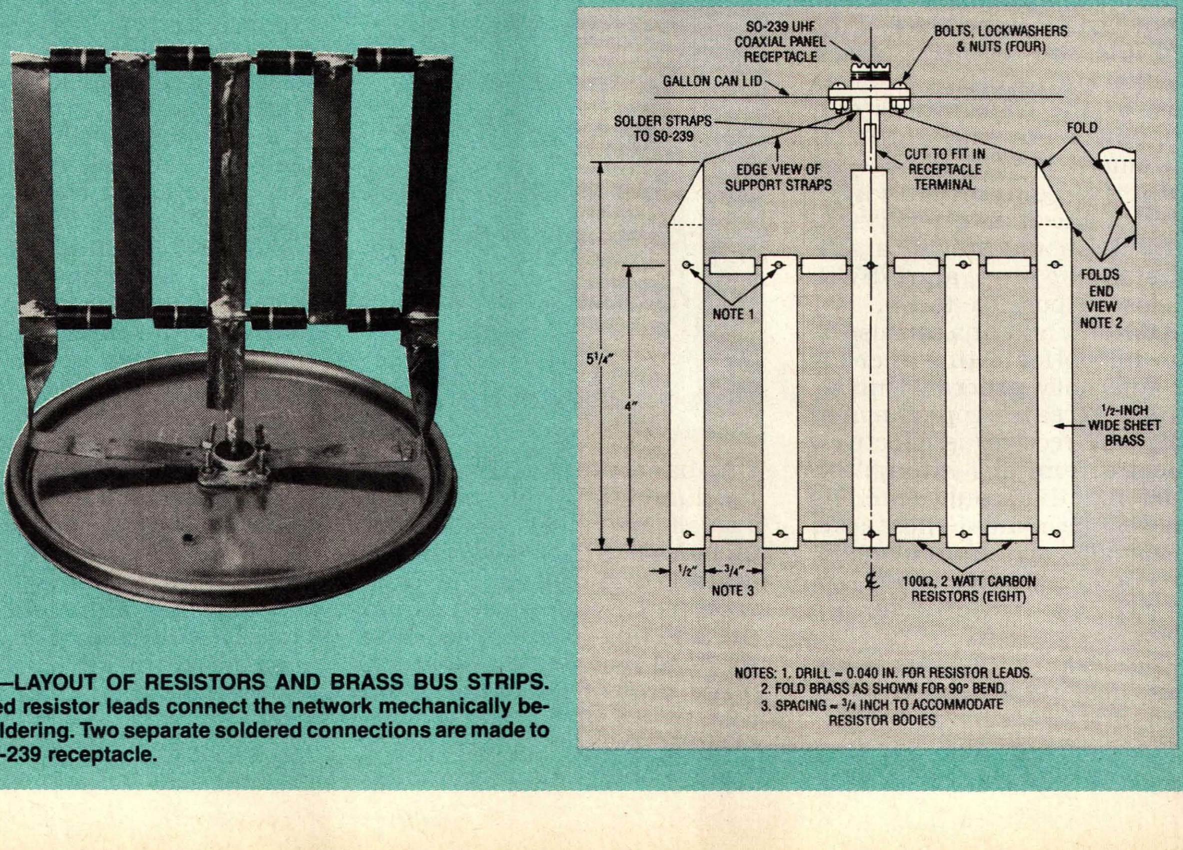

LID
BOLTS, NUTS & WASHERS (FOUR) (SEE TEXT)
SO-239 UHF COAXIAL PANEL RECEPTACLE
SOLDERED CONNECTIONS
1/2 INCH WIDE BRASS STRIPS
12 DRILLED VENT HOLES
EIGHT 100-OHM 2-WATT CARBON-COMPOSITION RESISTORS
1 GALLON CAN

FIG. 1—A 50-OHM, 100-WATT, UHF DUMMY ANTENNA. Brass strips form a low-resistance bus for the series-parallel resistor network. The one-gallon can protects against burns and electric shock.

Assembling the network

Refer to Fig. 2, the resistor and bus layout drawing, and start construction by cutting one strip 15 inches long for supporting the network from the shell of the receptacle. Cut a semicircular notch about ¼-inch deep by ⅜-inch wide at the middle of the strip to provide clearance around the coaxial terminal at the back end of the SO-239 receptacle. This will still provide an adequate surface for soldering the completed network to the end of the receptacle's shell, later in the project.

Then cut another strip about 6 inches long and cut a narrow tongue at one end that can be press-fit into coaxial sleeve at the receptacle's end. Next cut two more strips 4 inches long. Drill the ten 0.040-inch holes in the brass strips in the locations shown in Fig. 2 for inserting and crimping the resistors later in the project. Clean the brass strips thoroughly with steel


SO-239 UHF COAXIAL PANEL RECEPTACLE
BOLTS, LOCKWASHERS & NUTS (FOUR)
GALLON CAN LID
SOLDER STRAPS TO S0-239
FOLD
EDGE VIEW OF SUPPORT STRAPS
CUT TO FIT IN RECEPTACLE TERMINAL
FOLDS END VIEW NOTE 2
NOTE 1
5¼"
4"
½-INCH WIDE SHEET BRASS
½"
¾"
NOTE 3
℄
100Ω, 2 WATT CARBON RESISTORS (EIGHT)

NOTES: 1. DRILL = 0.040 IN. FOR RESISTOR LEADS.
2. FOLD BRASS AS SHOWN FOR 90° BEND.
3. SPACING = ¾ INCH TO ACCOMMODATE RESISTOR BODIES

FIG. 2—LAYOUT OF RESISTORS AND BRASS BUS STRIPS. Crimped resistor leads connect the network mechanically before soldering. Two separate soldered connections are made to the SO-239 receptacle.

wool or abrasive cleaning powder and water to remove surface oxzidation, oil, or grease. Wash and dry the strips.

Fold the ends of the 15-inch strip as shown in Figs. 1 and 2 so that the central section will be bent 90° away from the vertical ends where the resistors are to be soldered.

The next step is to bend and insert the axial leads of the resistors in the drilled holes and crimp them to link the network together mechanially before doing any soldering. Lay out the brass strips as shown in Fig. 2, and position the ten resistors between the strips. With pliers, bend the leads 90° so that they can be inserted into the holes drilled in adjacent strips, allowing room for the resistors to fit between the edges of the strips.

Insert the resistor leads, trim their ends, and fold them back on themselves. Then crimp them flat against the brass strips. Set the mechanically "linked" network aside.

Prepare the container

Drill a ⅜-inch hole in the center of the can lid by first drilling a pilot hole with a small drill or center drill. With a round file, carefully enlarge the ⅜-inch hole until the SO-239 jack is admitted snugly. With a felt tip pen, mark the centers of the four holes on the receptacle's panel-mounting plate on the lid top. Punch the centers with a nail or nail set, and drill them for the four 10-32 bolts.

Position the receptacle on the outside of the lid, and fasten it with four ¼-inch long 10-32 bolts, lockwashers, and nuts.

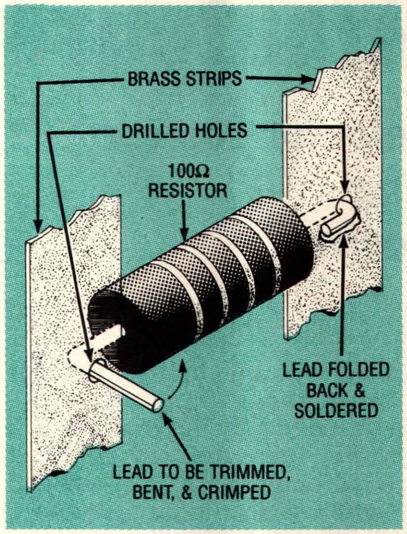
Drill 12 ventilation holes with the ⅜-inch drill in four vertical columns of three, 90° apart as shown in Fig. 1. Start first with pilot holes as previously described. The can will isolate the hot resistors from contact with your hands and prevent any fire or shock hazard when the dummy antenna is in use. The holes will permit cooling air to circulate within the closed can so there will be no dangerous heat build-up.

PARTS LIST

Miscellaneous: one-gallon paint can and lid; eight 100-ohm, 2-watt resistors; SO-239 UHF coaxial panel receptacle; four sets of 10-32 bolts (¼-inch long) with nuts and lockwashers; solder.

With a large soldering iron (100 watts or more) or a soldering gun, solder the folded resistor leads of the network to the brass strips, while preserving the network arrangement. It might take 10 to 20 seconds to raise the brass strips to solder flow temperature. After the resistor network is complete, set it aside to cool.

Insert the narrow tongue of the central strip into the receptacle's solder sleeve and solder that connection. Then clamp the notched part of the strap to the side of the receptacle shell and solder that connection.


BRASS STRIPS
DRILLED HOLES
100Ω RESISTOR
LEAD FOLDED BACK & SOLDERED
LEAD TO BE TRIMMED, BENT, & CRIMPED

DETAIL OF RESISTOR-LEAD BENDING and crimping to adjacent brass strips to form a mechanical assembly before soldering.

Testing the load

The author's tests showed that the standing-wave ratio of this dummy antenna never exceeded 1.5:1 over the shortwave band from 160 to 10 meters. *Caution: Regardless of modulation technique, do not operate continuously at up to 100 watts for more than 30 seconds.* This limitation should not restrict most amateur radio transmitter tuning. Ω

NOVEL AMMETER

continued from page 60

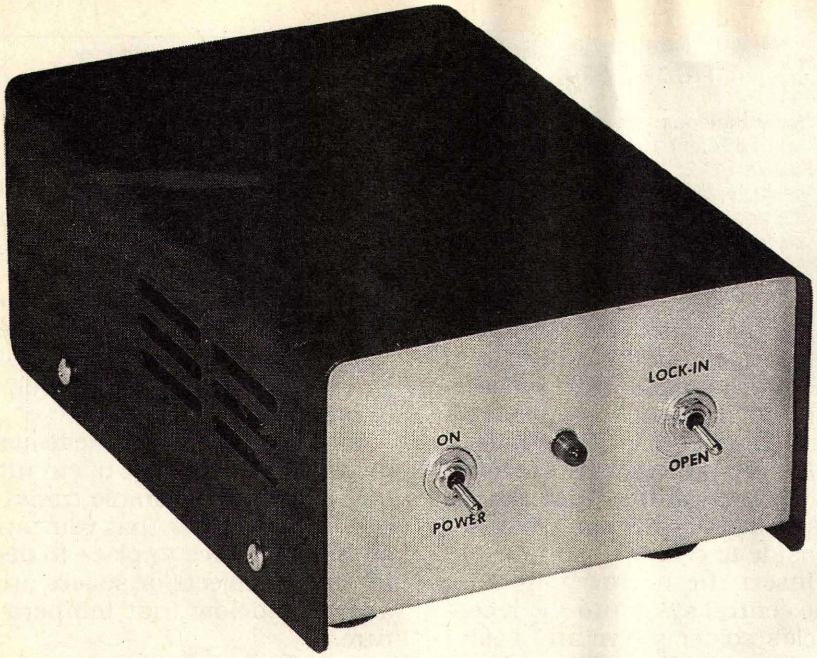
ture of 43°C (109.4°F). For this application, cut off the terminal pads and mount the part flush with the surface of the object whose temperature is to be determined. This instrument can be used to warn you that the temperature at the surface of equipment or within an enclosure exceeds 109.4°F.

You can also mount the tester on a 1 by 4 inch piece of circuit board to make a simple transition thermometer that you can move from place to place to determine if objects or spaces are above or below that temperature.

Applications precautions

Remember that the tester is an inexpensive thin-film sensor-display that can be damaged by excessive heat or current. Here are some precautions to take that will assure good results in your experiments and projects:

- *Do Not* use the tester in direct sunlight or where the ambient temperature never falls below 42°C.
- *Do Not* mount the tester directly to or with heat-conducting material when making an ammeter. Heat conductors will degrade the tester's response time and sensitivity. At least a 1⁄16-inch thick insulating "cushion" will provide adequate thermal isolation.
- *Do Not* pass more than about 300 milliamperes through the resistive element. (See Figs. 3 and 4.) If higher operating currents are required, shunt the resistive element with a discrete resistor of the proper value.
- *Do Not* experiment with or use the tester where flammable or explosive gas or other materials are present. If overheated, the tester will act as a pyrotechnic fuze.
- *Do Not* make sharp bends or creases in the tester because the resistive element will be damaged. However, sharp bends can be formed in the terminal area of the tester without causing damage. Ω



Autopatch Selector for Radio Amateurs

With our autopatch selector you can control almost anything from your UHF transceiver.

PETER A. LOVELOCK

THE SIMPLEX AUTOPATCH, A CIRCUIT that allows amateur radio operators to access the dial-up telephone system from their UHF transceivers, is perhaps the next best thing to a cellular telephone. The problem is, however, that when the autopatch is part of the amateur's own station it is usually limited to one particular transceiver, yet the ham operator might be using two or three transceivers to cover several different amateur bands.

Changing the autopatch's connections to work with more than one transceiver—so that operation is possible on more than one band—normally involves a lot of cable juggling and tends to bring on expletives. Don't forget that there's no way to juggle the connections if there's no one around to do it. Since the autopatch itself is controlled by received DTMF tones, there's no reason why a DTMF signal can't be used to switch the autopatch between various transceivers. That's what this device does.

To prevent unauthorized users from making free telephone calls from your station, an autopatch is normally activated and connected to the telephone line by a special DTMF access code that is broadcast by the remote transceiver. In a similar manner, an autopatch selector that instantly connects the autopatch to one of several transceivers could be controlled by adding a DTMF prefix to the existing autopatch access tones. The autopatch circuitry is shown in Fig. 1.

DTMF

DTMF (dual-tone multifrequency) is the telephone system's standard for "valid tone pairs" that are generated whenever a button on a *Touch Tone*-type keypad is pressed. Each button generates a distinct combination of one low-frequency and one high-frequency tone. Standard telephones use a twelve-button pad labeled 0–9, *, and #. For special applications, the keypads on many amateur radio VHF/UHF handheld and mobile radios have four additional tone combinations that are labeled A–D.

Apart from telephone dialing, the valid tone pairs (referred to as *valid tones*) can be decoded at the receiving end to control almost any function, such as accessing repeaters and simplex autopatches, and even turning on a coffee pot.

Autopatch connection

Figure 2 shows a block diagram of a standard simplex autopatch base-station hookup that provides a connection between a transceiver and the telephone line. The autopatch will not be connected to the telephone line until it receives its access code from the transceiver, which gets the code from the received signal.

Figure 3 is a block diagram showing how a DTMF-controlled autopatch selector connects either of two transceivers to the autopatch. Depending on the received valid-tones prefix, an autopatch selector can connect any of two or more base radios to the single autopatch. Since both the selector unit and the autopatch incorporate DTMF decoders, it is essential that the prefix's valid tones be different from those used for the autopatch access code. For example, if the keypad has 16 DTMF tone-buttons, buttons A, B, and C might be used for the prefixes that connects the autopatch to any of three transceivers, while the # button might be used to reset the selector when the autopatch is in an *option mode* that we'll describe later.

If your remote transceiver's

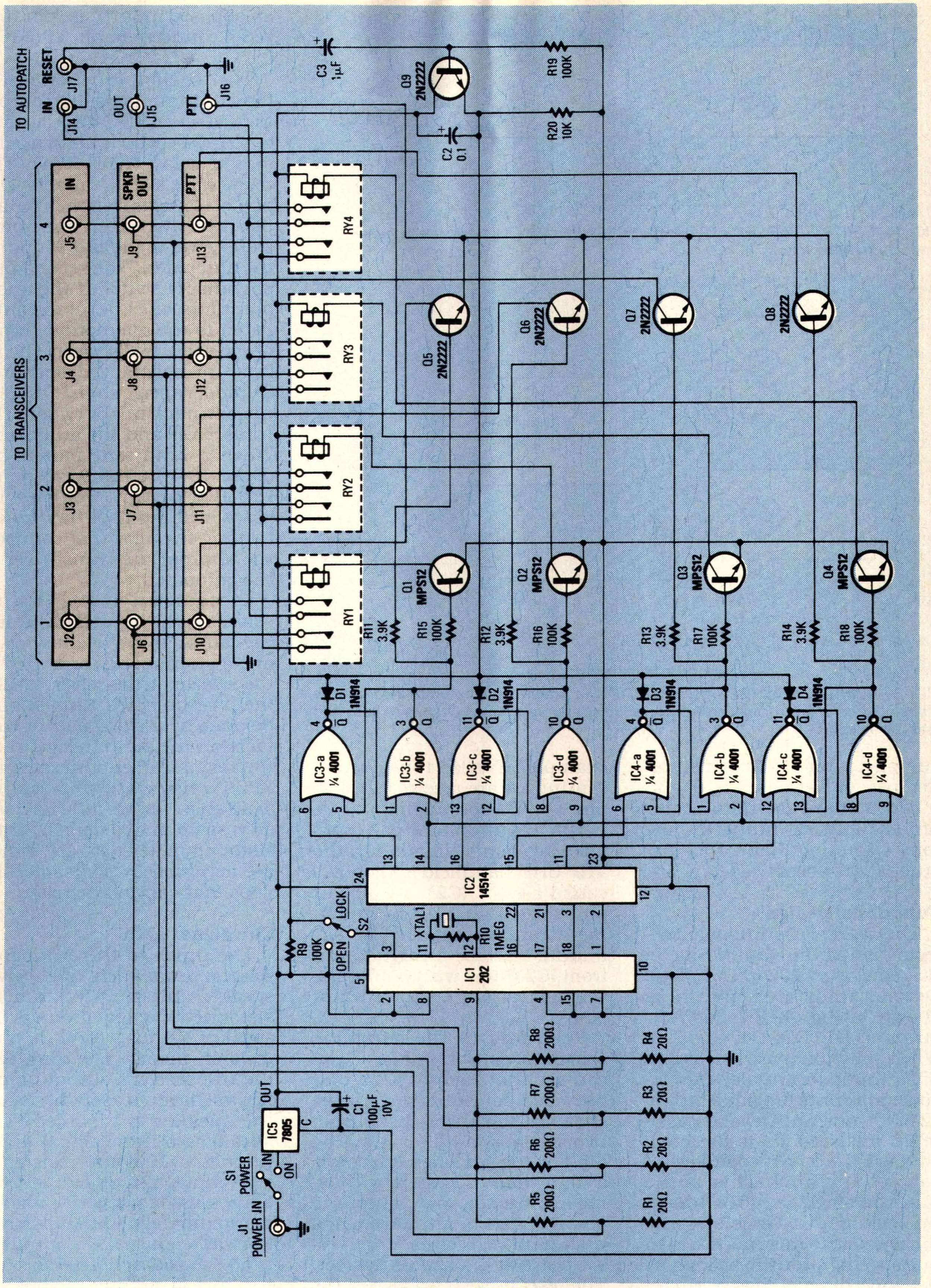

TO AUTOPATCH
IN
RESET
J14
J17
OUT
J15
PTT
J16
C3
1µF
Q9
2N2222
R19
100K
R20
10K
C2
0.1
TO TRANSCEIVERS
1
2
3
4
IN
SPKR OUT
PTT
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
RY1
RY2
RY3
RY4
Q1
MPS12
Q2
MPS12
Q3
MPS12
Q4
MPS12
Q5
2N2222
Q6
2N2222
Q7
2N2222
Q8
2N2222
R11
3.9K
R12
3.9K
R13
3.9K
R14
3.9K
R15
100K
R16
100K
R17
100K
R18
100K
D1
1N914
D2
1N914
D3
1N914
D4
1N914
IC3-a
¼ 4001
IC3-b
¼ 4001
IC3-c
¼ 4001
IC3-d
¼ 4001
IC4-a
¼ 4001
IC4-b
¼ 4001
IC4-c
¼ 4001
IC4-d
¼ 4001
Q
Q̄
IC2
14514
IC1
202
XTAL1
R10
1MEG
LOCK
S2
OPEN
R9
100K
R5
200Ω
R6
200Ω
R7
200Ω
R8
200Ω
R1
20Ω
R2
20Ω
R3
20Ω
R4
20Ω
IC5
7805
IN
OUT
C
C1
100µF
10V
S1
POWER
ON
J1
POWER IN

FIG. 1—ALTHOUGH ONLY FOUR CONTROL RELAYS ARE SHOWN, you can use up to the full 16-output capability of IC2. The circuit is intended for switching transceivers, but it can also be used to control other kinds of devices.

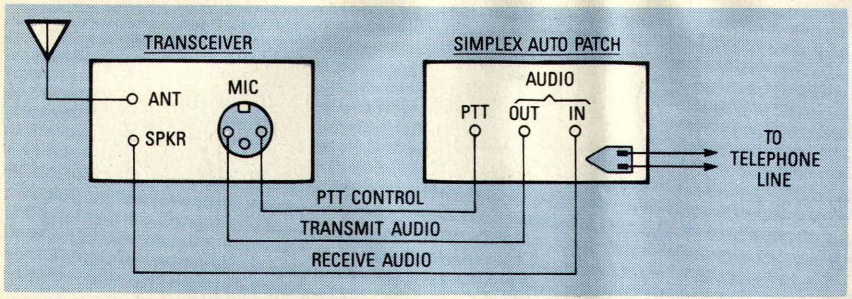


FIG. 2—TYPICAL SIMPLEX AUTOPATCH CONNECTION. It interfaces the telephone line to a transceiver.

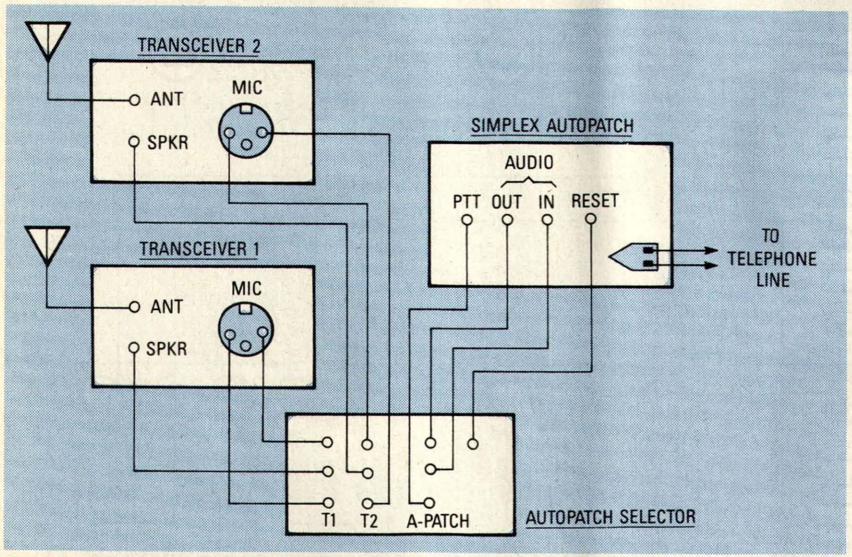


FIG. 3—USING THE AUTOPATCH SELECTOR, a single simplex autopatch can be shared by two or more transceivers. You build as many switching circuits as you need into the selector.

keypad has only 12 buttons, valid tones for buttons 7, 8, 9, and 0 can be used for the selector prefix, limiting numeric buttons 1 through 6 and * for the autopatch's access code.

Functional design

The heart of the autopatch selector is IC1, an 18-pin Silicon Systems type 202 DTMF Tone Decoder integrated circuit. As shown in Fig. 4, IC1 has four outputs: D1, D2, D4, and D8. When valid tones are received at IC1's input terminals, the decoder's outputs provide a binary "2 of 8" code until a valid pause of 40 milliseconds is detected. By itself, the binary code doesn't control anything. This is the function of IC2, a 14514 4-to-16 line decoder. It translates the binary code to raise one of its 16 outputs high for the as long as the tone decoder has a binary output. As shown in Fig. 4, the high period is directly related to the tone pair being received; for example, if valid tones representing a 1 are received by IC2, pin 9 of IC2 goes high.

The 16-button tone pad that's used by many amateur radio VHF/UHF handheld radios will cause any of IC2's 16 output pins to go high, thereby initiating a control function. We say *initiate* because a high output from IC2 drops within 40 milliseconds after the tone input stops.

Referring to the complete schematic shown in Fig. 1, you can see that each of IC2's outputs are connected to a one-shot flip-flop that's made from two sections of IC3 or IC4. The flip-flop toggles when it receives a high from IC2, thereby causing its normally-low $\overline{Q}$ output to go high. The Q output remains high until it receives a high reset pulse at $\overline{Q}$. (That is correct. The reset pulse is applied to the flip-flop's $\overline{Q}$ output terminal, but if you trace the connection you'll find that the $\overline{Q}$ connects to an opposed input; e.g., pin 10 of IC3-c connects to pin 11 of IC3-c.)

The toggling function of the flip-flop permits its high output to turn on an MPS-12 relay driver (Q1–Q4), which in turn actuates a relay (RY1–RY4). The relays have DPST contacts. One pair of contacts switches the audio output (speaker) line from a transceiver to the audio input of the autopatch. The second pair of contacts switches the audio output (phone line) of the autopatch to the microphone input of the same transceiver. The relays are normally deactivated (contacts open), so that there is no connection between the transceiver and the autopatch. When a valid tone pair is detected by IC1, the corresponding IC2 output toggles its associated flip-flop, thereby activating the relay that connects the appropriate transceiver to the autopatch.

In addition to the transceiver's audio input and output, the autopatch's PUSH-TO-TALK line (PTT) must be connected to the selected transceiver. Ideally, the (PTT)-line switching should be done by a third pair of contacts on the active relay. Unfortunately, small and inexpensive 3PST relays are not readily available. As an alternative, (PTT) switching is done by transistor amplifiers Q5–Q7, which are activated by the same flip-flops that control the relays.

The signal path

The input to the autopatch selector from each transceiver speaker output is fed to a resistor network that grounds the speaker output with a 20-ohm resistor, thereby ensuring that the transceiver's output amplifier will have a reasonable load if the speaker is disabled. The speaker's output signal is fed through a 200-ohm resistor to IC1's input, pin 9. The 20/200-ohm resistor network provides approximately 15-dB of isolation between speaker outputs.

The autopatch selector has two operating modes that are controlled by switch S2. When S2 is set to the OPEN position (the switch is actually closed)

IC2 responds to all output signals from all the transceivers, even if one is already connected to the autopatch. Thus more than one radio can be connected to the autopatch in a party-line fashion. In this mode the tones generated by the keypad's # button will disconnect the autopatch selector.

When S2 is set to the LOCK position (the switch is actually open), the first received valid tone pair toggles the associated flip-flop, whose $\overline{Q}$ output drives the reset line low. This low eventually appears on pin 3 of IC3. That disables IC1's crystal oscillator, thereby inhibiting a response to any other tones as long as pin 3 remains low. Thus, the autopatch selector is captured by the first valid prefix tones, and will not permit access by any other prefix until the reset line receives a high pulse that resets the active flip-flop.

PARTS LIST

All resistors are ¼ watt, 10%, unless otherwise noted
R1–R4—20 ohms, ½ watt
R5–R8—200 ohms
R9, R15–R19—100,000 ohms
R10—1 megohm
R11–R14—3900 ohms
R20—10,000 ohms
All capacitors are rated at least 10-volts DC
C1—100 µF, electrolytic
C2—0.01 µF, ceramic
C3—1 µF, electrolytic
Semiconductors
IC1—Silicon Systems 202P DTMF Decoder
IC2—MC14514 4-to-16 line decoder (Motorola) or equivalent
IC3, IC4—4001 quad 2-input NOR gate
IC5—7805 5-volt regulator
Q1–Q4—MPS12 NPN transistor
Q5–Q9—2N2222 NPN transistor
D1–D4—1N914 diode
Other components
J1—Coaxial power jack to match power supply
J2–J16—phono jacks
RY1–RY4—DPDT relay
S1—SPST switch
S2—SPDT switch
XTAL1—3.58-MHz colorburst crystal holder
Miscellaneous: Prototyping board, IC sockets, cabinet, wire, solder.

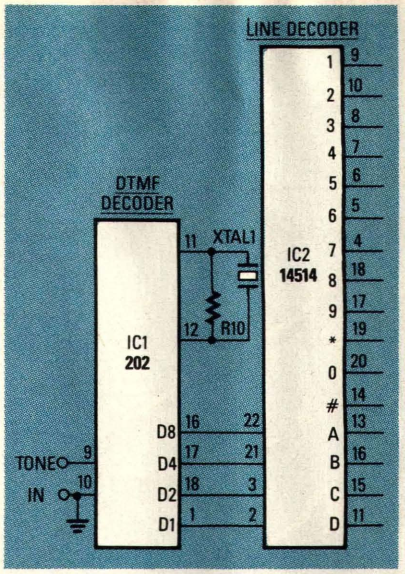


FIG. 4—IC1 DECODES THE DTMF INPUT TONES into a four-line binary-coded decimal output, which IC2 decodes into 16 outputs corresponding to keypad buttons 0–9, *, #, A, B, C, and D.

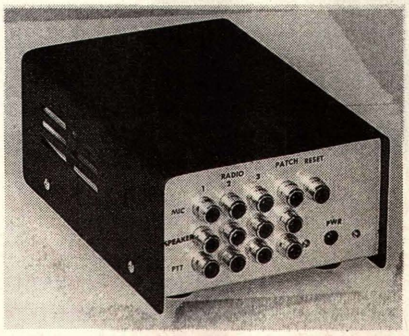


FIG. 5—THE PROTOTYPE UNIT IS ASSEMBLED on an IC-pattern wiring board. The jacks are mounted on the back of the case.

The diode at the Q output of each flip-flop prevents the low on the reset line from toggling the inactive flip-flops.

The OPEN mode would be generally used because it prevents more than one transceiver from accessing the autopatch.

The reset high is generated by the autopatch when it is deactivated, either by receipt of the shutdown tone-code, or by its internal timeout clock. That requires a single connection within the autopatch to a point that is normally high when the autopatch is *off*, and low when the autopatch is *on*. In the case of the commonly-used *Private Patch I*, the most suitable connection is to pin 14 of IC14. A single wire should be carefully soldered to that pin and to the spare phono jack on the rear of the autopatch. With other brands of simplex autopatch unit, it will be necessary to find a logic point for the reset function that is high when the autopatch is *off*, and low when the autopatch is *on*.

The reset high from the autopatch is fed through emitter-follower buffer-amplifier Q9, whose input RC time constant provides a momentary 1-second high to the selector's reset line.

More control

The 16 available control outputs of IC2 are unlikely to be needed for switching sixteen transceivers to the autopatch; two to six radios are more likely. But by using additional flip-flops and relay drivers connected in the same way as those shown in Fig. 1, the unused IC2 outputs can control other devices, such as antenna switchers and rotators.

Construction

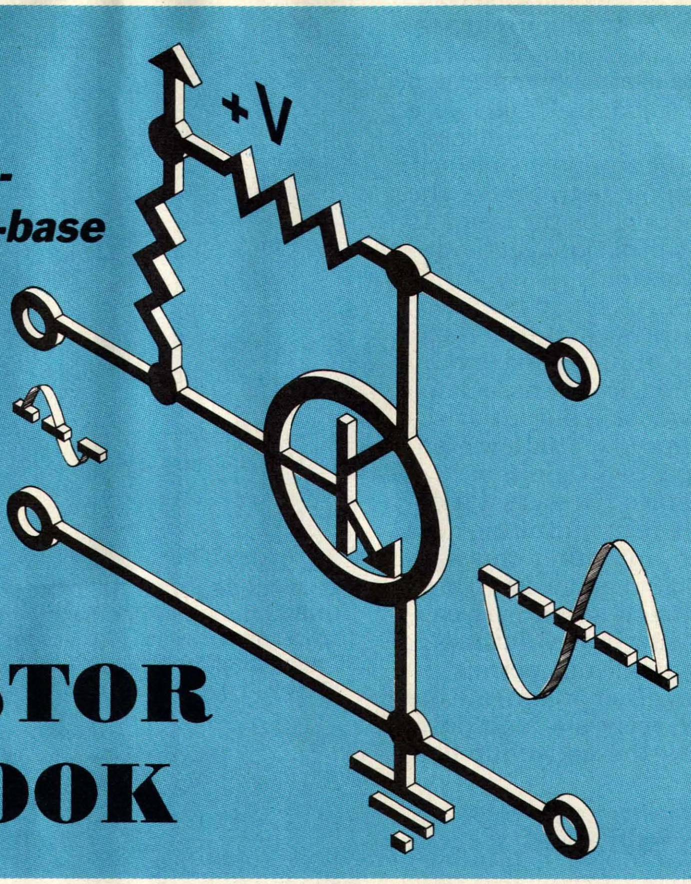
The prototype autopatch selector was hand-wired on a 4 × 2¾-inch IC-prototyping board. The board is mounted in a 4½ × 5 × 2-inch aluminum cabinet. The jacks for the transceiver interconnections are installed on the rear apron, along with power supply jack J1.

The required regulated 5 volts at 100 milliamperes can be supplied by one of the associated transceivers. If that is done connect J1 directly across C1, and eliminate the 5-volt regulator (IC5). If you cannot take the power from a transceiver, use the regulator circuit shown in Fig. 1, and drive J1 with the output from a 12-volt DC adapter.

Alternate uses

Although developed primarily for switching an autopatch between transceivers, the switcher can use DTMF tones to control just about anything with a radio. For example, a single DTMF tone can be used to turn base radios on and off, switch antennas, and change frequencies. You could even use the switcher to control the lights in your home from a remote transceiver. Ω

Learn about common-emitter and common-base bipolar transistor amplifiers to help you design your own circuits.



TRANSISTOR COOKBOOK

RAY MARSTON

THE CHARACTERISTICS OF COMMON-emitter and common-base bipolar junction transistor (BJT) amplifiers differ from those of the common-collector amplifier—and each other. Those amplifiers are the subjects of this article. Last month the common-collector amplifier was discussed in detail in this series, and many different practical circuits were presented.

Figure 1 shows the three basic bipolar transistor amplifier circuits. It was reprinted from last month's article as was Table 1, which compares the characteristics of the three basic transistor amplifiers. Examination of Table 1 will reveal that the common-collector amplifier (Fig. 1-a) provides near-unity voltage gain, while presenting high input and very low output impedance.

Recall from last month's article that the common-collector amplifier is applied both as a unity-gain *voltage follower* and an impedance converter. By contrast, both the common-emitter (Fig. 1-b) and common-base amplifier (Fig. 1-c) circuits provide high-voltage gain, so they function primarily as voltage amplifiers. The common-base circuit, for example, offers near unity current gain, so it usually functions as a wide-band or high-frequency voltage amplifier.

The common-emitter circuit, on the other hand, offers both high current gain and high voltage gain, making it an attractive high-gain power amplifier. This circuit, also known as a grounded-emitter circuit, is typically functions as a digital or analog amplifier.

Digital circuitry

Figure 2 is a schematic for a simple NPN common-emitter amplifier that can function as a digital amplifier, inverter, or switch. The input signal can be either zero volts or a high positive value. (It should be higher than 0.6 volt but less than the power supply voltage.) When the input is at zero volts, the transistor is fully cut off; in that state the output equals the positive power supply voltage.

When the input is switched to a positive value greater than 0.6 volt (the value needed to forward bias the base-emitter junction of a 2N3904 transistor), the transistor turns on. Collector current flows in load resistor R_L and "pulls" the output voltage toward zero.

If the input voltage is high enough, the transistor is driven fully on, or into *saturation*. Then the output voltage falls to a saturation value of only 0.2 to 0.3 volt. As a result, the output signal is an inverted version of the input waveform.

In Fig. 2, resistor R_B acts principally as a protective device to limit the base-drive current to a non-destructive value. The input impedance of the circuit is slightly greater than the R_B value. The value of resistor R_B is inversely related to the waveform rise and fall times: The higher its value, the slower are those times.

This circuit drawback can be

TABLE 1
CHARACTERISTICS OF THE THREE BASIC TRANSISTOR AMPLIFIERS

Parameters		**Common Collector**	**Common Emitter**	**Common Base**
Input impedance	Z_{IN}	High ($\approx h_{FE} \times R_L$)	Medium ($\approx$1.0K)	Low ($\approx 40\Omega$)
Output impedance	Z_{OUT}	Very low	$\approx R_L$	$\approx R_L$
Voltage gain	A_V	$\approx$1	High	High
Current gain	A_I	$\approx h_{FE}$	$\approx h_{FE}$	$\approx$1
Cutoff Frequency	—	Medium	Low	High
Voltage phase shift.	—	0°	180°	0°

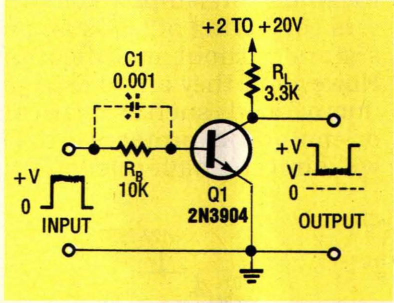

+2 TO +20V
C1
0.001
R_L
3.3K
+V
V
0
R_B
10K
Q1
2N3904
+V
0
INPUT
OUTPUT

FIG. 2—DIGITAL INVERTER/SWITCH based on an NPN transistor.

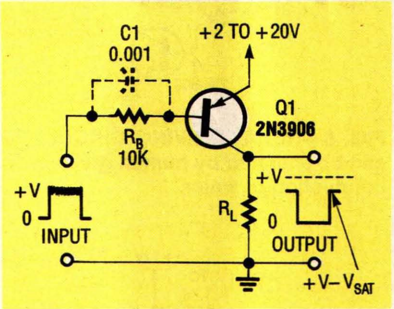

C1
0.001
+2 TO +20V
R_B
10K
Q1
2N3906
+V
0
INPUT
R_L
+V
0
OUTPUT
+V– V_SAT

FIG. 3—DIGITAL/INVERTER/SWITCH based on a PNP transistor.

overcome by shunting R_B with a "speed-up" capacitor with a value of about 0.001 µF, as shown dotted in Fig. 2. In practical applications, R_B should have as low a value as practical, consistent with protecting the transistor and input-impedance requirements. However, it should *never* be greater than $R_L \times h_{FE}$.

Figure 3 is the schematic for a PNP version of the digital inverter or switch circuit. Here the transistor is switched fully ON when the input is zero volts. In that condition, the output is about 0.2 volt less than the positive power supply value. The 2N3906 transistor turns off only when the input rises to a value that is within 0.6 volt of the supply value. The output then falls to zero volts.

The ability of the circuits in Figs. 2 and 3 to respond to lower input signals (sensitivity) can be increased by replacing Q1 with two transistors in a Darlington pair. The circuits in both Figs. 4 and 5 are high-gain, non-inverting digital amplifiers or digital switches.

The circuit in Fig. 4 which includes the Darlington pair of NPN transistors operates as follows: When the input signal is zero volts, Q1 is cut off, effectively removing it from the circuit. Under this condition, Q2 is driven into saturation through resistor R2, and the output signal has a threshold value of 0.2 to 0.4 volt.

By contrast, if the input signal is significantly greater than 0.6 volt, Q1 is driven into saturation and pulls the base of Q2 down to only about 0.2 volt above zero. Under this condition, Q2 is cut off and the output is at the full supply voltage.

The circuit in Fig. 5, which includes one NPN and one PNP transistor, operates in a different way than that described for Fig. 4. When the input is at zero volts, Q1 is cut off, which, in turn, cuts off Q2 through resistors R2 and R3. Therefore, the output value is zero volts.

However, when the input to the base of Q1 goes high (above 0.6 volt), Q1 is driven on and obtains most of its collector current from the base of Q2 through R3. This action drives Q2 into saturation. When this happens, the output reaches a value about 0.2 volt less than the positive supply voltage.

Figure 6 is a conceptual sche-

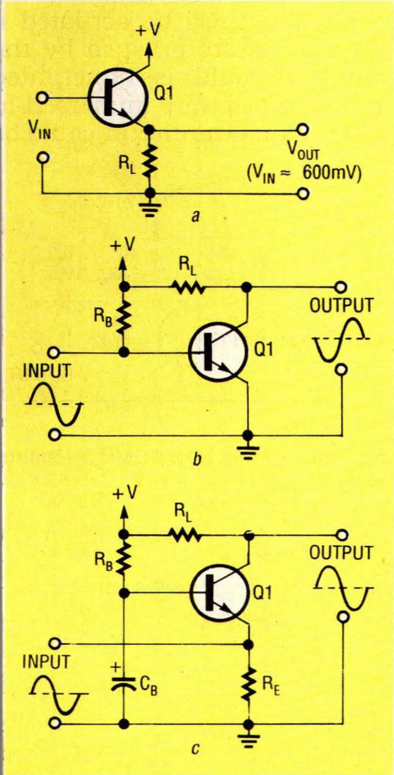

+V
Q1
V_IN
R_L
V_OUT
(V_IN ≈ 600mV)
a
+V
R_L
R_B
OUTPUT
Q1
INPUT
b
+V
R_L
R_B
OUTPUT
Q1
INPUT
C_B
R_E
c

FIG. 1—THREE BASIC TRANSISTOR amplifiers: common- collector (*a*), common-emitter (*b*), and common-base (*c*).

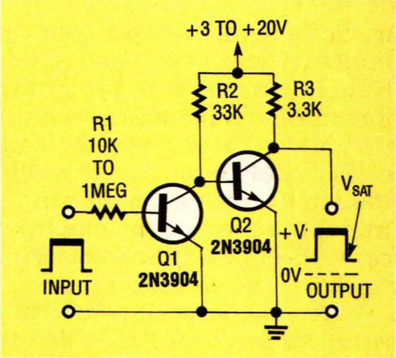

+3 TO +20V
R2
33K
R3
3.3K
R1
10K
TO
1MEG
V_SAT
Q2
2N3904
+V
INPUT
Q1
2N3904
0V
OUTPUT

FIG. 4—HIGH-GAIN, NON-INVERTING digital amplifier based on a single NPN transistor.

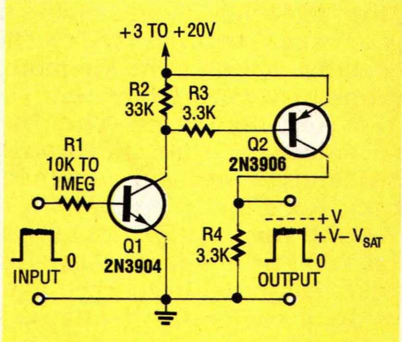

+3 TO +20V
R2
33K
R3
3.3K
Q2
2N3906
R1
10K TO
1MEG
+V
+V– V_SAT
R4
3.3K
0
0
INPUT
Q1
2N3904
OUTPUT

FIG. 5—ALTERNATIVE NON-INVERTING digital amplifier or switch with NPN and PNP transistors.

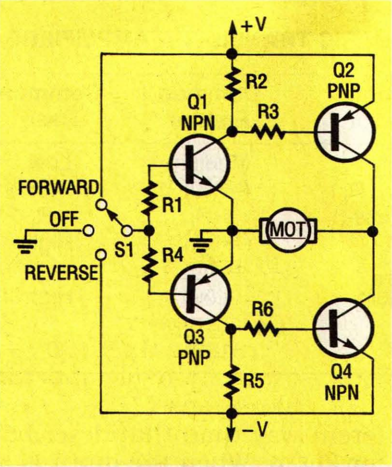

+V
R2
Q2
PNP
Q1
NPN
R3
FORWARD
OFF
R1
MOT
S1
R4
REVERSE
R6
Q3
PNP
Q4
NPN
R5
-V

FIG. 6—DC-MOTOR DIRECTION CONTROL circuit shown without component values.

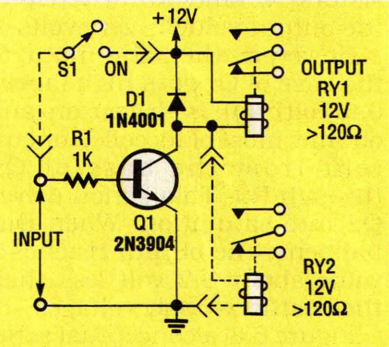

+12V
S1
ON
OUTPUT
RY1
12V
>120Ω
D1
1N4001
R1
1K
Q1
2N3904
INPUT
RY2
12V
>120Ω

FIG. 7—SIMPLE RELAY-DRIVING circuit.

matic showing how the complementary pair of transistors from Fig. 5 can be organized to form a DC-motor control circuit with a dual power supply. This circuit could be operated by digital logic, and has applications in robotics or other machine control. This is how the circuit works:

When switch S1 is in the FORWARD position, Q1 is driven on through R1, and Q2 is driven on through R3 by Q1. However, Q3 is cut off through R4, and Q4 is cut off by R5 and R6. Thus the "live" side of the motor is connected through Q2 to the positive supply, and the motor runs in a forward direction.

When S1 is in the OFF position, Q1 is cut off through R1, and Q2 is cut off through R2 and R3. Simultaneously Q3 is cut off through R4, and Q4 is cut off through R5 and R6. Under this condition, the "live" side of the motor is open-circuited so the motor does not run.

Finally, when S1 is in the REVERSE position, Q3 is biased on through R4, and Q4 is driven on through R6 and Q3. However, Q1 is cut off through R1, and Q2 is cut off through R2 and R3. Therefore, the "live" side of the motor is connected through Q4 to the negative power supply, and the motor runs in the reverse direction.

Relay drivers

The basic digital circuits shown in Figs. 3 to 5 can drive a variety of resistive loads such as incandescent lamps and indicators consisting of LEDs and resistors without modification. However, if they are to drive inductive loads such as relay coils or motors, a protective diode will limit the high turn-off voltage to a value that can be handled safely by the transistor.

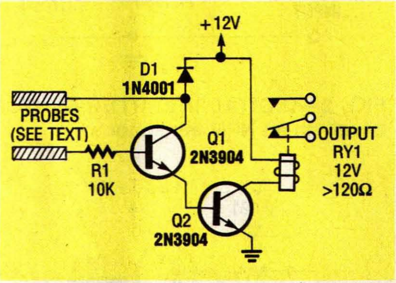

+12V
D1
1N4001
PROBES
(SEE TEXT)
R1
10K
Q1
2N3904
OUTPUT
RY1
12V
>120Ω
Q2
2N3904

FIG. 8—RELAY-DRIVING CIRCUIT that can be actuated by human grasp or the conduction of water.

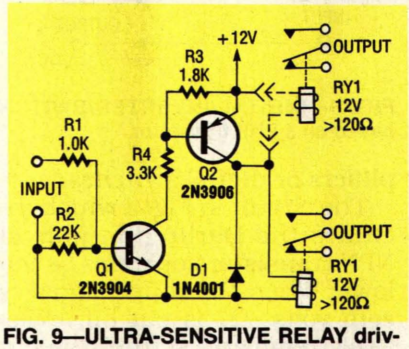

+12V
OUTPUT
R3
1.8K
RY1
12V
>120Ω
R1
1.0K
R4
3.3K
Q2
2N3906
INPUT
R2
22K
Q1
2N3904
D1
1N4001
OUTPUT
RY1
12V
>120Ω

FIG. 9—ULTRA-SENSITIVE RELAY driver needs a 0.7-volt, 40-microampere input.

Common-emitter amplifiers are more sensitive relay drivers than the common-collector amplifiers described last month. Figures 7, 8, and 9 are practical common-emitter relay-driving circuits.

Figure 7, for example, is the schematic for a simple but versatile single-transistor relay driver. It increases the relay's operating current sensitivity by a factor of about 200 (the nominal h_{FE} value of transistor Q1). Resistor R1, which provides base-drive protection, can have a larger value than the 1 kilohm shown in Fig. 7.

The relay can be turned on either by applying a DC input voltage greater than 0.7 volt or by operating switch S1 (shown as a plug-in component connected by dotted lines).

The circuit shown in Fig. 7 is non-latching, but it can be made self-latching by including another relay (RY2) between the collector and emitter of Q1, as shown in the diagram. The circuit's current sensitivity is limited by the current gain of Q1 but it can be increased to abou 20,000 by replacing Q1 with a Darlington pair as shown in Fig. 8.

In a practical application, th relay in the Fig. 8 circuit can b actuated by shorting a pair o stainless-steel probes, each with a resistance value less than a few megohms. Tap water and human skin have resistance valies under a few megohms, so this circuit can function as a water, or touch-operated relay switch.

The relay will be actuated i the probes are grasped by th hands. It would also be actuated if the probes were immersed in water. Thus the circuit could b

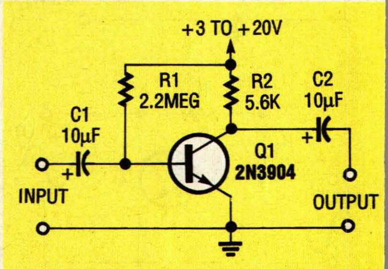

+3 TO +20V
R1
2.2MEG
R2
5.6K
C2
10µF
C1
10µF
Q1
2N3904
INPUT
OUTPUT

FIG. 10—SIMPLE NPN COMMON-emitte amplifier.

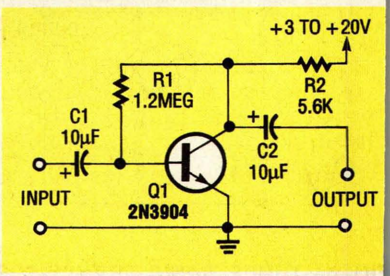
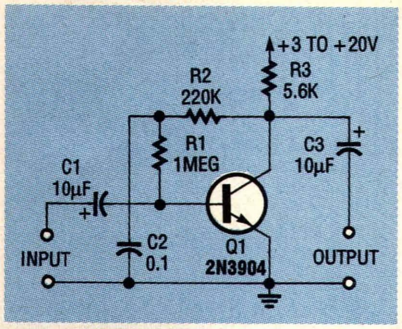
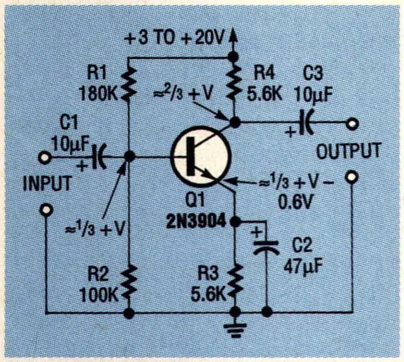

+3 TO +20V
R1
1.2MEG
R2
5.6K
C1
10µF
C2
10µF
Q1
2N3904
INPUT
OUTPUT

FIG. 11—COMMON-EMITTER amplifi with feedback biasing.



+3 TO +20V
R2
220K
R3
5.6K
R1
1MEG
C3
10µF
C1
10µF
C2
0.1
Q1
2N3904
INPUT
OUTPUT

FIG. 12—COMMON-EMITTER amplifier with AC-decoupled feedback biasing.



+3 TO +20V
R1
180K
≈2/3 +V
R4
5.6K
C3
10µF
C1
10µF
OUTPUT
INPUT
≈1/3 +V
Q1
2N3904
≈1/3 +V− 0.6V
C2
47µF
R2
100K
R3
5.6K

FIG. 13—COMMON-EMITTER amplifier with voltage-divider biasing.

part of a water-level alarm circuit. The relay can actuate an auxiliary alarm circuit if rising water shorts the probes.

Figure 9 is a schematic for another ultra-sensitive, dual-transistor relay driver (based on Fig. 5). An input of about 0.7 volt at 40 microamperes is needed to actuate the relay. The 22-kilohm resistor between the base and the emitter of Q1 ensures that both Q1 and Q2 are fully cut off if the input terminals are open-circuited.

Linear biasing circuits

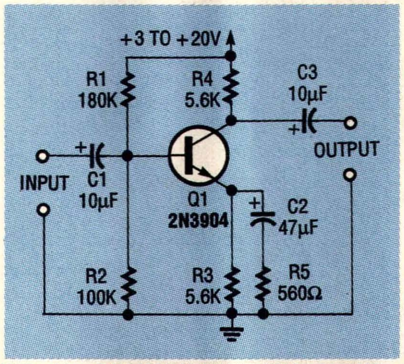
Figure 10 shows how a common-emitter amplifier can become a linear AC amplifier. This is done by applying a DC bias current to the base of Q1 so that the collector's quiescent value is about half its supply voltage. This bias permits the amplifier to accommodate high AC output swings without distorting them. The AC-input signal is applied between the base and ground of Q1, and the AC-output signal is taken between the collector and ground.

To design an AC amplifier as shown in Fig. 10, first decide on the value of load resistor R2. The lower this resistance value, the higher will be the amplifier's upper cut-off frequency. (This is due to the lower shunting effects of stray output capacitance on the effective impedance of the load.)

Moreover, a low value of R2 will cause a higher quiescent operating current in Q1. In Fig. 10, resistor R2 has a value of 5.6 kilohms, a compromise that will amplify a frequency of about 120 kHz and draw about a milliampere of quiescent current from a 12-volt supply. To bias the output to half the supply voltage, R1 must have a value of $R2 \times 2h_{FE}$.

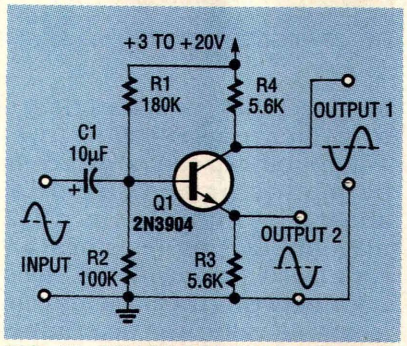
$R1 = 2 \times 2h_{FE} = 2 \times 200 \times 5600 \approx 2.2$ megohms

where R2 is 5600 ohms and h_{FE} is 200



+3 TO +20V
R1
180K
R4
5.6K
C3
10µF
OUTPUT
INPUT
C1
10µF
Q1
2N3904
C2
47µF
R2
100K
R3
5.6K
R5
560Ω

FIG. 14—COMMON-EMITTER amplifier with a fixed gain of 10.



+3 TO +20V
R1
180K
R4
5.6K
OUTPUT 1
C1
10µF
Q1
2N3904
OUTPUT 2
INPUT
R2
100K
R3
5.6K

FIG. 15—PHASE-SPLITTER with unity gain.

Input impedance and voltage gain for this circuit are both determined by the impedance of transistor Q1's internal base-to-emitter junction. For a 2N3904, this value will be about $25/I_C$, where I_C is the collector current value in milliamperes. (This impedance is 25 ohms at 1 mA, 12.5 ohms at 2 mA, or 50 ohms at 0.5 mA.)

The input impedance into the transistor base is:

$Z_{IN} = h_{FE} \times 25/I_C$
$= 200 \times 25 = \approx 5$ kilohms at 1 mA (shunted by R1)

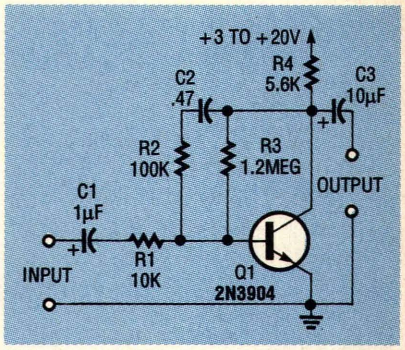
The voltage gain (A_v) of the circuit in Fig. 10 is calculated as follows:

$A_v = R2/25/I_C = 5600/25$
$= \approx 200$ at 1mA

This gain figure (which translates into approximately 46 dB, also determines the theoretical maximum attainable upper frequency response, measured at the −3-dB point of the frequency response curve. It equals f_T/A_v where f_T is the transit time limit of minority carriers across the base region. (f_T is the frequency at which h_{FE} decreases to unity, and is the measure of the transistor's high-frequency performance.) The f_T of the 2N3904 is about 300 MHz.

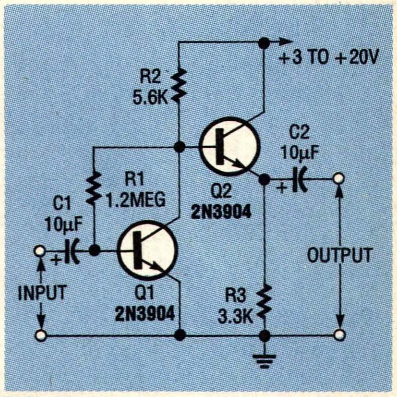
Therefore, the maximum frequency response of the circuit in Fig. 10 (ignoring the effects of stray capacitance) is 300 MHz/200 = ≈ 1.5 MHz.

A shortcoming of the Fig. 10 circuit is that its quiescent



+3 TO +20V
R4
5.6K
C2
.47
C3
10µF
R2
100K
R3
1.2MEG
OUTPUT
C1
1µF
R1
10K
INPUT
Q1
2N3904

FIG. 16—ALTERNATIVE AMPLIFIER with a fixed gain of 10.



+3 TO +20V
R2
5.6K
C2
10µF
R1
1.2MEG
Q2
2N3904
C1
10µF
OUTPUT
INPUT
Q1
2N3904
R3
3.3K

FIG. 17—WIDEBAND, TWO-STAGE common-emitter amplifier.

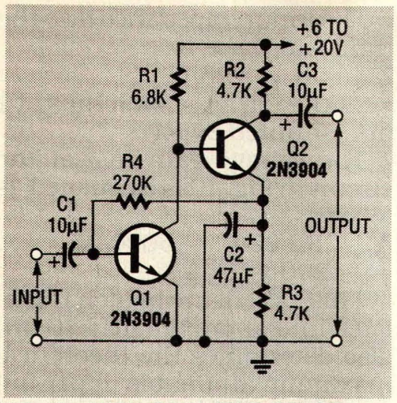

+6 TO +20V
R1 6.8K
R2 4.7K
C3 10µF
Q2 2N3904
R4 270K
C1 10µF
C2 47µF
OUTPUT
INPUT
Q1 2N3904
R3 4.7K

FIG. 18—HIGH-GAIN, TWO-STAGE amplifier.

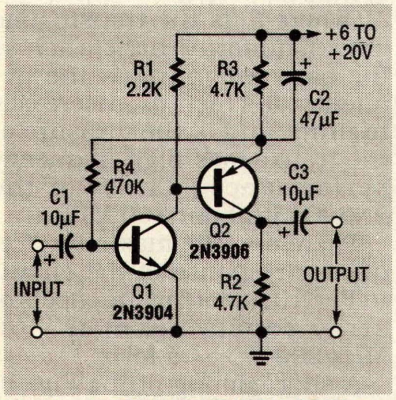

+6 TO +20V
R1 2.2K
R3 4.7K
C2 47µF
R4 470K
C3 10µF
C1 10µF
Q2 2N3906
INPUT
Q1 2N3904
R2 4.7K
OUTPUT

FIG. 19—ALTERNATIVE HIGH-GAIN two-stage amplifier.

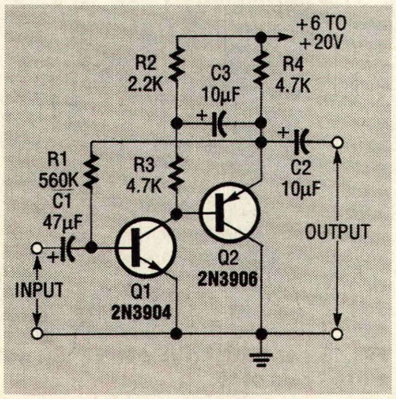

+6 TO +20V
R2 2.2K
C3 10µF
R4 4.7K
R1 560K
R3 4.7K
C2 10µF
C1 47µF
OUTPUT
INPUT
Q1 2N3904
Q2 2N3906

FIG. 20—BOOTSTRAPPED HIGH-GAIN two-stage amplifier.

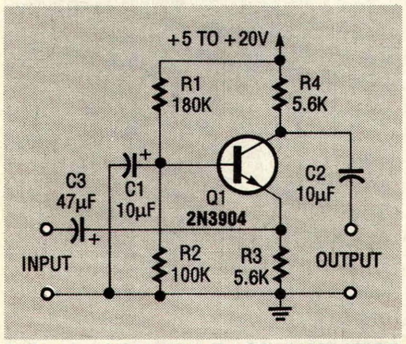

+5 TO +20V
R1 180K
R4 5.6K
C3 47µF
C1 10µF
Q1 2N3904
C2 10µF
INPUT
R2 100K
R3 5.6K
OUTPUT

FIG. 21—COMMON-BASE AMPLIFIER with two output terminals.

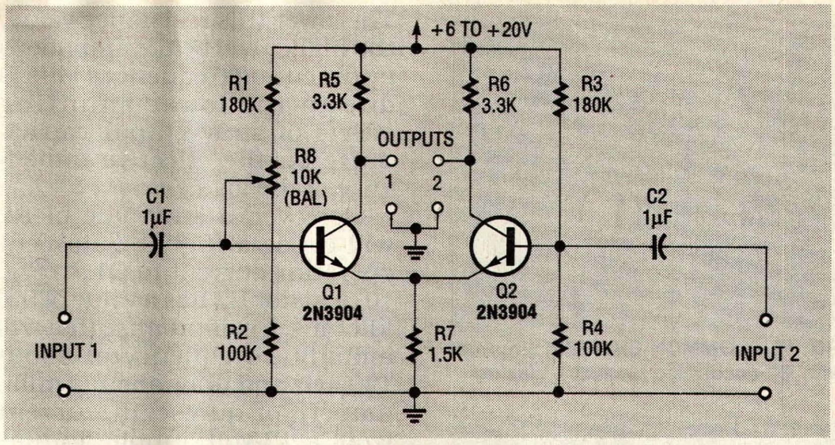

+6 TO +20V
R1 180K
R5 3.3K
R6 3.3K
R3 180K
OUTPUTS
R8 10K (BAL)
1
2
C1 1µF
C2 1µF
Q1 2N3904
Q2 2N3904
R2 100K
R7 1.5K
R4 100K
INPUT 1
INPUT 2

FIG. 22—DIFFERENTIAL AMPLIFIER OR "LONG-TAILED" pair.

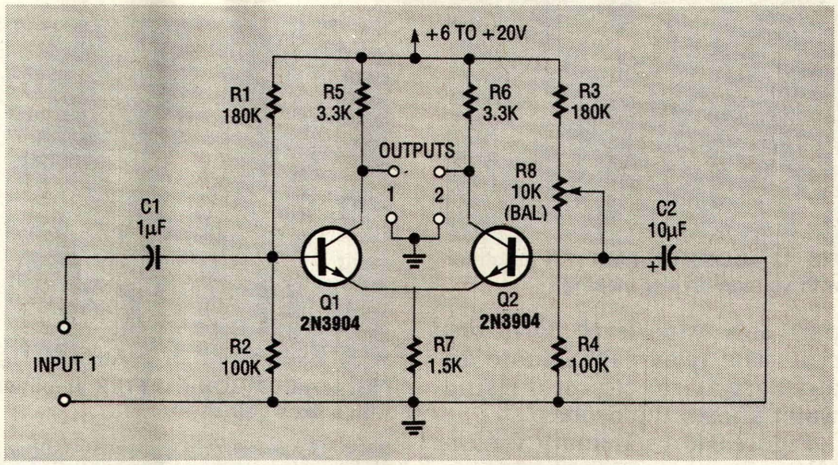

+6 TO +20V
R1 180K
R5 3.3K
R6 3.3K
R3 180K
OUTPUTS
1
2
R8 10K (BAL)
C1 1µF
C2 10µF
Q1 2N3904
Q2 2N3904
INPUT 1
R2 100K
R7 1.5K
R4 100K

FIG. 23—PHASE-SPLITTER based on the differential amplifier.

biasing point is a function of transistor current gain (h_{FE}). This handicap can be overcome by modifying the circuit as shown in Fig. 11. Here 1.2-megohm biasing resistor R1 is connected to provide DC feedback between the base and collector. Its value was determined by multiplying R2 (5.6 kilohms) by h_{FE} (200).

Feedback occurs when any shift in the output biasing point takes place due to variations in h_{FE}, ambient temperature changes, or a shift in critical value of a connected passive component. Feedback automatically introduces a counteracting current in the base-current bias, which tends to cancel the original shift.

The Fig. 11 circuit offers the same bandwidth and voltage gain as the circuit in Fig. 10, but it has a lower input impedance because the AC feedback of the Fig. 11 circuit reduces the effective value of resistor R1. That resistor, which shunts the 5-kilohm base impedance of Q1, is reduced by the voltage gain of 200. As a result, total input impedance is 2.7 kilohms.

The shunting effects of the biasing network can be eliminated with two feedback resistors and AC decoupling capacitors, as shown in Fig. 12.

The ultimate in biasing stability can be obtained with *potential-divider biasing* as shown in Fig. 13. Here, the voltage divider formed by junction of resistors R1 and R2 applies a quiescent voltage slightly higher than one-third of the supply voltage on the base of Q1. "Voltage- follower" action reduces the supply voltage at Q1's emitter by 0.6 volt.

As a result, one-third of the supply voltage is developed

Continued on page 86

HARDWARE HACKER

Dialog and Usenet access and data compression secrets.

DON LANCASTER

Contacting and communicating intelligently with knowledgeable persons can be a serious hardware hacking problem. Finding out who has written what, when, and where can also be. But this month, a pair of really big events occurred that make two crucial hacker resources cheaper and far easier to use.

Usenet

Usenet, often called *Anarchy 101*, is a giant national computer network that connects virtually *all* schools and universities, research labs, most high-tech firms, and the larger government agencies. Unlike typical BBS systems, it has no true sysop (system operator). Nor is there any central memory bank. Everybody talks to everybody else in any way, at any time. Usenet is totally unstructured. For instance, mere *minutes* after Fermat's last theorem had been solved, the proof was spreading like wildfire on Usenet. (I've uploaded a condensed proof outline to my *GEnie* PSRT as #753 FERMAT.TXT.)

Nearly all insiders in any technical field have Usenet addresses. But the trouble has been that Usenet access had to be obtained through a sponsoring organization. And becoming a Usenet sponsor involves big bucks. So access by individuals was by invitation only, and largely catch as catch can.

GEnie has recently opened a new Usenet E-mail gateway. There is no surcharge for this access; its just part of GEnie's hourly rate, which is typically $3 per hour. GEnie can be accessed through a local phone number for the majority of **Electronics Now** readers.

Let's say someone has a Usenet address of

clyde@bark.newco.org

To E-mail them from GEnie, the address would be

clyde@bark.newco.org@INET#

That @INET# trailer does the link-up for you. Similarly, say you want to reach me from Usenet through my *SYNERGETICS* GEnie email address. Use

Synergetics@GEnie.GEIS.com

as a Usenet address. For anyone else, just add

@GEnie.GEIS.com

as the trailer to the *GEnie* E-mail address.

Because my PSRT works on shared information, answers for a technical E-mail question are posted directly to the PSRT RoundTable. A two hour response time is typical; response times can be even shorter, if you are lucky.

There seems to be a convention in any Usenet message that *must* be obeyed at all times. *Be verbose!* A simple "yes" or "no" answer will *never* do. The people you deal with on Usenet are mostly academic folks who favor Unix.

You'll first describe every wire that your message travels over. Then you give your entire genealogy on back to your great grandmother's cousin twice removed. Then you quote verbatim anything and everything anyone else has ever said on the subject, back to day one.

NEED HELP?

Phone or write your **Hardware Hacker** questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher, AZ 85552

(602) 428-4073

For fast **PSRT** access, modem (800) 638-8369, then an HHH. Then XTX99005,SCRIPT.

Then you say your "yes" or "no" in as oblique a manner as possible. Then say something that is supposed to be funny. Then quote something long and somewhat literate that Chekhov would find totally obtuse. Finally, issue a disclaimer that a gaggle of Byzantine lawyers would find bulletproof. Then say goodbye.

Aim for a bare minimum of half a megabyte per yes/no E-mail message response. Otherwise "they" will spot you as a rank outsider.

Dialog

I've long recommended the *Dialog Information Service* because Dialog can give you instant answers to *any* technical question in *any* field of study. From anywhere. At any time. At last count, Dialog had some 300,000,000 citations in stock—all as abstracts and many in full text—spread out over some 400 major databases.

Even paying the standard $2 per minute rate, I felt Dialog had been by far the fastest, cheapest, and the most reliable way I have ever found to do research. It's especially valuable when searching for information in fields that you know little about.

Dialog also offered a quarter-price late-evening service, but you had to subscribe to it on your own. And precious minutes could be gobbled up if you were not extremely careful with your keystrokes. And if things hung up, so did your bill.

Dialog has now turned its entire afterhours marketing to *CompuServe* that in turn has made it available to *GEnie*. Type DIALOG for access.

The really big breakthrough now is that there are no more by-the-minute Dialog charges. Instead, the setup is strictly cash and carry, with sharply reduced prices. A search will typically cost $2.50 if you find something, and $1.50 if you don't.

The abstracts, in lots of ten, can cost a total of $3. That's *thirty cents* per citation or abstract! Some complex searches cost more, but the prices are all sharply reduced from what they were before. Dialog also offers a *supersearch* feature, in which a few databases can be searched simultaneously. Hard copies and CD-ROM access is also available.

I've tried tq list a few of the more hacker-useful Dialog databases in Fig. 1. I tend to use the INSPEC database from the IEEE a lot. It is strong in electronics, computers, and physics. Two similar databases you might want to check out are *MathSci* and *Compendex*.

But don't forget all the everyday stuff that is available from Dialog, including *Books in Print*, *Ulricht's Periodicals*, the *Encyclopedia of Associations*, and the good old *Thomas Registry of Manufacturers*.

Book Review Index-	Two million reviews of books and periodicals.
Books in Print-	Everything published by author, subject, title.
CA Search-	Ten million entry chemisty data base.
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Current Contents-	Contents of leading scientific and tech jounals.
Derwent World Patents-	Has six million worldwide patents.
Dialog Quotes-	Stock and option prices, delayed 20 minutes.
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EI Compendex-	4500 engineering and technology journals.
Electric Power Database-	Commercial power R & D projects.
Encyclopedia of Associations-	Lists 81,000 organizations worldwide.
Energy Technology-	Database for the US Department of energy.
Federal Register-	Everything by the government printing office.
Foundation Directory-	Lists 32,500 organizations that give money away.
Geobase-	Geography, geology, and ecology data base.
INSPEC-	Physics, electronics, and computing data base.
Magazine Index-	Covers 500 popular magzazines.
Mathsci-	Abstracts for math, computers, and statistics.
Microcomputer Index-	Articles from 50 microcomputer journals.
NTIS-	National technical information service database.
Peterson's College Database-	Complete guide to US colleges.
Publisher's and Distributers-	Who publishes what, when, and where.
Scisearch-	Multidisciplinary index to science and technology.
Thomas Register-	Directory of all manufacturers of everything.
Ulricht's Periodicals-	Lists 100,000 publications in all fields.
U.S. Patent Abstracts-	A complete patent repository.

Fig. 1—THE DIALOG INFORMATION SERVICE is newly available on a low-cost, cash-and-carry basis. Of its 400+ databases, I use these the most.

Data transmission and compression

I've recently found some new ways to compress data quickly, simply, and cheaply, so, I thought we might go over the fundamentals here.

The basic unit of data measure is the eight-bit *byte*. As many bytes as are needed are combined to create

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PostScript by Example (McGilton)	29.50
Real World Postscript (Roth)	22.50
PostScript Visual Approach (Smith)	22.50
Thinking in PostScript (Reid)	22.50
Undst PS Pgrmmg (Holtzgang)	29.50
The Whole Works (all PostScript)	349.50

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a total message, image, program, fax page, song, video field, or whatever you have in mind.

A byte can be sent all bits at once in *parallel* form, as is done through parallel printer ports or SCSI interfaces. Or a byte might be sent in *serial* form, one bit at a time, as is done through serial ports, *AppleTalk*, *Ethernet*, or MIDI links. *UART* hardware or *SCC* software converts from parallel to serial and back.

Any 8-bit byte has 256 possible states. If all of the states are needed for the data itself, the data is said to be in a *binary* format. If, instead, the data represents text, it is usually in an *ASCII* format.

The *ASCII* character code appears in Fig. 2. ASCII was originally only *seven* bits long and corresponded to 128 possible states. Thirty-two of them were reserved mostly for the upper-case characters, another 32 for lower-case. Yet another 32 were set aside for numbers and punctuation, and a final 32 for "invisible" *control characters* for functions such as linefeeds, carriage returns, bells, end-of-file markers, tabs, or backspaces.

	LOWER HEX VALUE															
UPPER HEX VALUE	–0	–1	–2	–3	–4	–5	–6	–7	–8	–9	–A	–B	–C	–D	–E	–F
0–	0 NUL \000	1 SOH \001	2 STX \002	3 ETX \003	4 EOT \004	5 ENQ \005	6 ACK \006	7 BEL \007	8 BS \010	9 HT \011	10 LF \012	11 VT \013	12 FF \014	13 CR \015	14 SO \016	15 SI \017
1–	16 DLE \020	17 DC1 \021	18 DC2 \022	19 DC3 \023	20 DC4 \024	21 NAK \025	22 SYN \026	23 ETB \027	24 CAN \030	25 EM \031	26 SUB \032	27 ESC \033	28 FS \034	29 GS \035	30 RS \036	31 US \037
2–	32 SP \040	33 ! \041	34 " \042	35 # \043	36 $ \044	37 % \045	38 & \046	39 ’ \047	40 (\050	41) \051	42 * \052	43 + \053	44 , \054	45 - \055	46 . \056	47 / \057
3–	48 0 \060	49 1 \061	50 2 \062	51 3 \063	52 4 \064	53 5 \065	54 6 \066	55 7 \067	56 8 \070	57 9 \071	58 : \072	59 ; \073	60 < \074	61 = \075	62 > \076	63 ? \077
4–	64 @ \100	65 A \101	66 B \102	67 C \103	68 D \104	69 E \105	70 F \106	71 G \107	72 H \110	73 I \111	74 J \112	75 K \113	76 L \114	77 M \115	78 N \116	79 O \117
5–	80 P \120	81 Q \121	82 R \122	83 S \123	84 T \124	85 U \125	86 V \126	87 W \127	88 X \130	89 Y \131	90 Z \132	91 [\133	92 \ \134	93] \135	94 ^ \136	95 _ \137
6–	96 ‘ \140	97 a \141	98 b \142	99 c \143	100 d \144	101 e \145	102 f \146	103 g \147	104 h \150	105 i \151	106 j \152	107 k \153	108 l \154	109 m \155	110 n \156	111 o \157
7–	112 p \160	113 q \161	114 r \162	115 s \163	116 t \164	117 u \165	118 v \166	119 w \167	120 x \170	121 y \171	122 z \172	123 { \173	124 | \174	125 } \175	126 ~ \176	127 DEL \177
8–	128 NUL \200	129 SOH \201	130 STX \202	131 ETX \203	132 EOT \204	133 ENQ \205	134 ACK \206	135 BEL \207	136 BS \210	137 HT \211	138 LF \212	139 VT \213	140 FF \214	141 CR \215	142 SO \216	143 SI \217
9–	144 DLE \220	145 DC1 \221	146 DC2 \222	147 DC3 \223	148 DC4 \224	149 NAK \225	150 SYN \226	151 ETB \227	152 CAN \230	153 EM \231	154 SUB \232	155 ESC \233	156 FS \234	157 GS \235	158 RS \236	159 US \237
A–	160 SP \240	161 ! \241	162 " \242	163 # \243	164 $ \244	165 % \245	166 & \246	167 ’ \247	168 (\250	169) \251	170 * \252	171 + \253	172 , \254	173 - \255	174 . \256	175 / \257
B–	176 0 \260	177 1 \261	178 2 \262	179 3 \263	180 4 \264	181 5 \265	182 6 \266	183 7 \267	184 8 \270	185 9 \271	186 : \272	187 ; \273	188 < \274	189 = \275	190 > \276	191 ? \277
C–	192 @ \300	193 A \301	194 B \302	195 C \303	196 D \304	197 E \305	198 F \306	199 G \307	200 H \310	201 I \311	202 J \312	203 K \313	204 L \314	205 M \315	206 N \316	207 O \317
D–	208 P \320	209 Q \321	210 R \322	211 S \323	212 T \324	213 U \325	214 V \326	215 W \327	216 X \330	217 Y \331	218 Z \332	219 [\333	220 \ \334	221] \335	222 ^ \336	223 _ \337
E–	224 ‘ \340	225 a \341	226 b \342	227 c \343	228 d \344	229 e \345	230 f \346	231 g \347	232 h \350	233 i \351	234 j \352	235 k \353	236 l \354	237 m \355	238 n \356	239 o \357
F–	240 p \360	241 q \361	242 r \362	243 s \363	244 t \364	245 u \365	246 v \366	247 w \367	248 x \370	249 y \371	250 z \372	251 { \373	252 | \374	253 } \375	254 ~ \376	255 DEL \377

Fig. 2—THE ASCII CHARACTER CODE. Since ASCII is really a seven bit code, it repeats twice in 8-bit space. The "high ASCII" area can alternately be unused, a different character set, graphic plotting commands, internal machine flags, or additional special symbols. Hex, decimal and octal values are shown.

To convert ASCII into an 8-bit code, it is simply repeated twice. Once with the most (MSB) significant bit cleared to zero (called *low ASCII*) and once with the MSB set to a one (called *high ASCII*). Sometimes only low ASCII actually is used. Other times, the high ASCII area might be reserved for an *alternate character set*, for *graphics commands*, or for *extensions* for characters such as as bullets, em dashes, or ellipses.

Gaining transparency

There is a thorny problem in using ASCII communications for data transmission. The channel is often *non-transparent*, which means that certain characters (such as carriage returns) are used for system purposes. Nearly all standard serial communication is non-transparent.

Should a random byte in a transmitted image have the same code as an end-of-file or other reserved character, you could end up in deep trouble.

The newer and better data-communications systems are totally *transparent*, and do not place any restrictions on the meaning that any byte can have. Examples of transparent data communications are *AppleTalk*, *SCSI*, and *EtherNet*.

Many older communication sys-

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Escape codes-	Reserves another character such as an escape or a "\". This "breakout" allows single problem characters to be sent as two non-problem ones.
Octal definitions-	Replaces problem characters as they occur with their four byte octal equivalent. Can become ungainly if used too often.
XMODEM comm-	Temporarily disables all special characters long enough for a fixed number of binary bytes to be sent. A standard for BBS uploads.
Hex-ASCII pairs-	Each binary byte is converted into a hex pair of printing ASCII characters. Doubles file size and transmission times.
ASCII-85 coding-	Each group of four binary bytes is converted into a new group of five print-only ASCII characters. Increases file size by 20 percent.
True transparency-	The channel is replaced with a better one that has no character reservations. Such as SCSI, EtherNet, AppleTalk, or other LAN systems.

Fig. 3—SOME TRANSPARENCY SCHEMES that let you send unrestricted binary data over a communication channel that reserves one or more ASCII codes.

Run length coding-	Replaces identical repeats with which byte to repeat how often. Used for black and white font bitmaps. Otherwise limited. Lossless.
FAX compression-	A variation on run length encoding for business letters and other "large white area" uses. Also known as the CCITT format. Lossless.
LZW compression-	The standard used for disk compaction. Offers a 2:1 to 3:1 reduction of most data forms. Noise sensitive because of low redundancy. Lossless.
DCT compression-	Uses the Discrete Cosine Transform to offer lots of compression for images and still video. Has "tiling" artifacts. Lossy.
JPEG and MPEG-	JPEG is just the most popular form of the DCT. MPEG adds motion estimation and differencing for movies and full motion video. Lossy.
Wavelets-	An improvement on DCT that has fewer artifacts and computes faster with simpler hardware and fewer tiling artifacts. Lossy.
Fractal math-	Front end intensive method that offers dramatic compression ratios of 1000:1 and beyond. Best for CD ROM image distribution. Lossy.
PostScript-	A general purpose computing language that uses extremely sparse data sets. Can greatly reduce the size of all graphic data. Lossless.

Fig. 4—HERE IS A SUMMARY of most of the more popular data-compression schemes in use today.

tems allow only non-transparent data, which means that you'll have to pull some sneaky "tricks" to send transparent data over them.

We can call all these methods *transparancy ploys*. Several are shown in figure three.

One simple method is *character substitution*. Here, an escape character or a reverse slash changes the meaning of a single character. You could also use an *octal notation* where any problem characters are replaced with, say, a reverse slash and the octal code of the problem characters.

Since the octal codes are all digits from 0-7, they can be routed over any non-transparent channel as print-only characters. For instance, a \67 should print as a "•" bullet in many *PostScript* systems.

Another trick is to make the communication channel transparent temporarily. That is the way that XMODEM and its improved offspring lets you upload full binary data to BBS systems or through E-mail. PostScript uses its *binary encodings* in a similar scheme. Total cooperation of sender, sendee, and the communication channel is manditory here.

A more general solution is called *hex format*. In hex format, each byte is broken into a high 4-bit sub-byte plus a low 4-bit sub-byte. Each sub-byte should have only sixteen possible values. Thus, it could be coded as the digits 0-9 and the letters A-F, and then sent out as printing characters. For instance, the letter A is ASCII coded as $61 or hex coded as $4641.

Hex format is easy and simple. Its obvious penalty is that it *doubles* the number of characters stored o sent. Everything takes twice as much storage space and takes twice as long to send—just wha you don't want.

A more subtle route is ASCII-85 In ASCII-85, binary bytes are grouped by fours, and each group o *four* bytes are sent as a group of *five* printing characters. Only the printing characters from *$AK* through are needed. In essence, ASCII-85 i a base-85 numbering system.

ASCII-85 sounds horrible. And i looks even worse on screen. But i is fairly simple to do and offers onl a 20 percent transmission penalt for a full transparency.

Compression fundamentals

Data compression is used t shorten a message so that it can b stored in less space, sent in les time, or transmitted over some na

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rower bandwidth channel. There are two penalties inherent in data compression: One is the time and effort needed to compress and uncompress. The second is that a compressed message inherently has less redundancy. Any errors in compressed data are likely to do bad damage, some of it unfixable.

A third "feature" of compression is that the compressed information is no longer human-readable.

There are many different types of data compression schemes which are popular today. Each one has its strengths and weaknesses. Each one will work very well for its intended use. And will perform poorly (even expanding the data!) for other uses. I've listed some of the more popular data compression schemes n Fig. 4.

Any data compression scheme is *lossless* if you can always get back *exactly* what you started out with. Obviously, electronic funds transfer and computer programs must pick a lossless compression scheme. A compression scheme is *lossy* if you get back only roughly what you started with. It would be useful for instance, in the tapioca-pudding scene in *Godzilla vs. the Night Nurses*. Your average couch potato won't spot a misplaced pixel or two.

Lossy data compression schemes can offer much higher compression ratios with a selected quality tradeoff. This is especially important in full motion video or when sending HDTV over a limited channel bandwidth.

Let's try to capture the flavor of a few compression schemes...

Run-length encoding. Run-length encoding works best with

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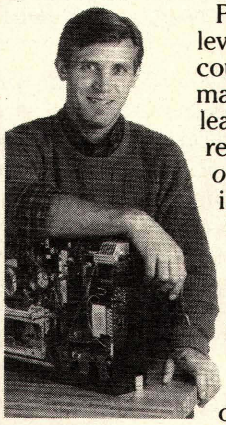

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```
% DCT compress a file and then ASCII85 encode it...

/sourcefilename (lena.histo.1) def                     % name source file
/targetfilename (lena.histo.dct.ascii85.1) def         % name target file

sourcefilename (r) file /source exch def               % open source file

targetfilename dup status {pop pop pop pop             % delete old target
deletefile}{pop} ifelse

targetfilename (w) file /target exch def               % open target file

5 dict  dup /DCTdict exch def begin                    % open work dictionary

save mark {                                            % start main loop

 /Rows 192 def                                         % height in pixels
 /Columns 256 def                                      % width in pixels
 /Colors 1 def                                         % one for b/w

 /buf Columns Colors mul string def                    % open work buffer

 target /ASCII85Encode filter /midtarget exch def      % define filters
 midtarget DCTdict /DCTEncode filter
 /filtertarget exch def

 Rows {filtertarget source buf readstring pop          % read-filter-write
 writestring} repeat

 filtertarget closefile                                % close files
 midtarget closefile
 target closefile

} stopped {handleerror} if cleartomark restore         % end main loop

end                                                    % close dictionary
```

Fig. 5—THIS DCT-COMPRESSED "LENA" IMAGE shows you how easy it is to do data compression in PostScript. The final fully transparent file size is 7K!

font bitmaps and monochrome graphics. It is lossless, and is especially good on data that contains long repeats of identical characters. A string of identical characters is replaced with codes for "repeat this character this many times."

Fax compression. This one is also called the CCITT format and is really a variation on run-length encoding. It is also lossless, and it is useful for sending monochrome documents with lots of white space—such as business letters.

Fax compression, in general, performs poorly on other data types. See application note No. 5115 from *Adobe Systems* for direct comparison of all major compression schemes. The title is *Supporting Data Compression in PostScript level II.*

LZW compression. LZH (short for Lempel-Ziv-Welch) is the standard for disk compaction. It is a totally lossless scheme that usually offers a 2:1 to 3:1 compression ratio.

DCT compression. DCT (direct cosine transform) compression is lossy, but it gives high compression for pictures and still video images. High quality compressions beyond 10:1 are typical. It can go beyond 30:1 with a modest loss of image quality. Resulting pictures can show objectional tiling artifacts, and the transform can be slow.

JPEG and MPEG. JPEG is simply another name for the most popular version of the DCT, as is used by the *Joint Photographic Expert Group*. It is often best for still images. MPEG by the *Moving Pictures Expert Group* is an extension of JPEG that allows significant squashing of full motion video and HDTV. It does that by overlaying *differencing* and *motion estimation*.

The MPEG compression results have proved to be impressive. MPEG should lead to full length videos on CD-ROM and the sending of HDTV over standard TV broadcast channels.

Wavelet compression. Wavelet compression is a stunning improvement over the DCT scheme. It eliminates many visual artifacts, can be coded more compactly, offers higher compression, and can execute faster. One champion of this new technology is *Aware*, which has lots of reprints and application notes available.

Fractal compression. Fractal compression is a unique and totally maverick new approach. For certain images, it offers compressions in the 1000:1 to 10,000:1 range. While a lot of front-end effort is required to squash an image, ordinary software can rebuild the images quickly—even as animation. Fractal compression is particularly useful for placing scads of stand-alone visual images on CD-ROM. The leader in this compression technology is *Iterated Systems* with its P-OEM process. See FRACTFERN.PS for a classic example.

PostScript. Few people realize that the PostScript language itself can be a uniquely powerful data compressor. This is true because of the sparse data sets normally used to create all PostScript page descriptions.

For instance, a scanned logo might need a half megabyte of file space if stored in one of the primitive "cuneiform and clay tablet" coding schemes used by early PC and Mac graphic programs. A far higher quality and faster executing version of the same logo can often be done in raw PostScript in as little as a few hundred bytes.

Compared to fax, typical pages in PostScript are much more compact, can be transmitted much faster, and offer "camera-ready" typeset quality. I cannot fathom why anyone would ever use fax for anything. I certainly don't.

Powerful new tools have been

added to PostScript recently to make it an even better data compressor. They include Adobe's *Distillery* program and *Acrobat* document system plus my own triple distilling routines. Much more on using these tools appears in the *PostScript Reference Manual II* "red book."

The obvious next question is how can you go about...

Compressing data

Any PostScript level II printer has built-in *filter* routines that let you encode or decode most compression schemes quickly and cheaply. Others filters can be added easily. Filters can even be layered on top of each other. As I've mentioned a time or three in the past, PostScript is a superb hacker's general-purpose computing language. It is also the simplest and fastest way to get started doing your own data compression work.

A sample program for PostScript DCT (or JPEG) data compression is shown in Fig. 5. It takes a disk-based binary format image and then DCT encodes it. After that, the data is made transparent by ASCII-85 filtering.

The results are fairly impressive. What starts as a 49-kilobyte binary file or a 98-kilobyte hex file becomes a 7-kilobyte file that can be sent over a non-transparent channel. Over transparent channels, the file could be as small as 5 kilobytes!

The differences in image quality are quite hard to spot, and are "good enough" for many desktop publishing jobs. Custom adjustments can be made for critical uses. Squash time is a few seconds.

We have a few suitable test images up on PSRT if you can't find your own. There are also examples there on how to do your own data compression filtering quickly and simply. In particular, see the following files:

LENA.PS
HACK56.PS
HACK69.PS
STR2FILE.PS
LENAHIST.PS
IMAGEKIT.PS
MANDRILL.PS
STARTUP.PS
SPEEDUP.PS.

Alternators as steppers

In several past issues and in *Hardware Hacker* reprints of them, we have seen how plain old car alternators can be converted into power steppers. A few files on this topic also appear on *GEnie* PSRT.

A new "down homey" video is now available that clearly shows you how to use car alternators as steppers in a humongous automated sign-routing machine. In its spare time, the same beast can create fancy and precision CAD/CAM parts for a weaving loom—heddles for example. Everything can be done totally homebrew at ultra low cost, with "found" materials. The video is $19.50 and is available from *John Reese*.

Magic resources

If the technology is advanced enough, it looks like magic. And I guess many Hardware Hackers see themselves as magicians of one sort of another. Except that hackers use new technology in place of the more traditional deception, distraction, and disorientation available.

My favorite "magic" trick is to put a photocell beside a lightbulb in a positive feedback loop. You can then "light" your lamp with a match. And then blow the light out. On the first try, use a gentle puff. On the second, you puff harder. And, of course, on the third try, you'll cup your hands around the lamp (blocking the optical feedback path) and big-bad-wolf it.

For our totally different resource sidebar this month, I thought we would list a few of those hard-to-find magazines and suppliers where real magicians go to buy their wands, top hats, rabbits, and whatever. There's certainly a lot of oddball stuff here. Some of it uniquely hackable.

New tech lit

From *Hewlett-Packard*, a fat new *Optoelectronic Designers Catalog* is available. It includes *LED* displays and optocouplers, along with bar code devices, fiberoptic communication, and robotic shaft encoders. From *Sharp*, a new bound collection of *Application Notes* on integrated circuits, liquid-crystal displays, RF components, and optoelectronics.

More information on Stirling heat engines appears in *Stirling Machine World*, which also carries several books and software items on the topic.

Michael Hackleman's *Alternative Transportation News* has become a new feature section of *Home Power Magazine*. There is plenty here on homebrew electric vehicles.

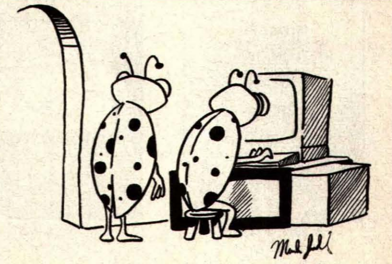
A good source for surplus hydraulic parts is *Roberts Electric*. Ultra-large alphanumeric displays that use "flip disk" technology are available from *F-P Electronics*.

Classic phone parts and replicas are offered by *Mahantango Manor*. These include 1907 *Farmer's Line Sets* in real quarter-sawn oak boxes.

A pair of unique and free product development resources is offered by *Batelle Pacific Northwest*: One is the *Inventor Assistance Source Directory*. The other the *Prototype Development Assistance Providers* list. But do not contact anyone on the second list unless your new product is already well into its third-party advanced beta testing stage, or you are willing to pay the industry standard development rates.

More on product-development topics also appears in *Midnight Engineering*. Speaking of that subject, I've gathered all of my previous columns from that magazine together into my *Blatant Opportunist* reprints. Technical innovation, new resources, product development, self-publishing, and hackable new concepts are covered. See my nearby *Synergetics* ad for more information on these.

The usual reminder here that I've listed most of the companies mentioned in this column in two sidebars, *Magic Resources* for the magician items, and *Names and Numbers* for everything else. Ω



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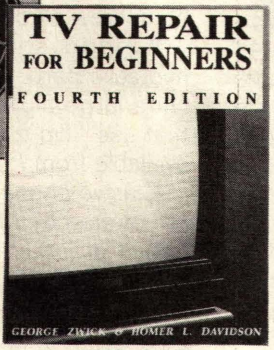
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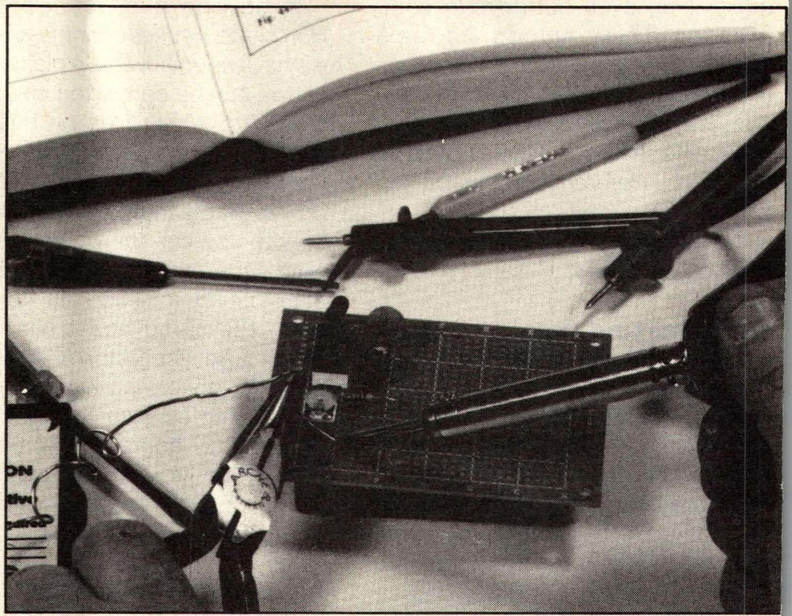

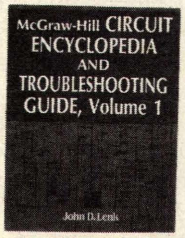
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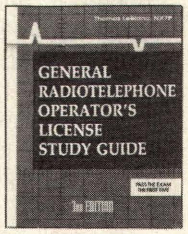
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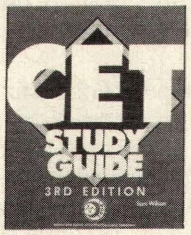
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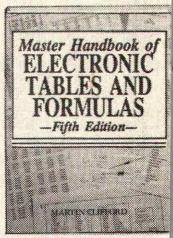
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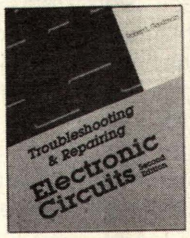
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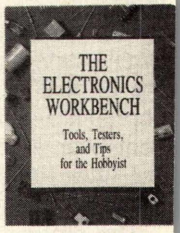
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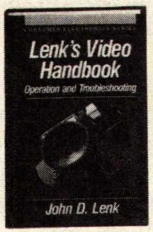
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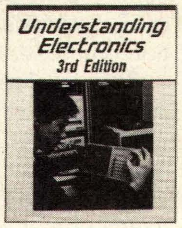
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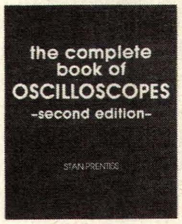
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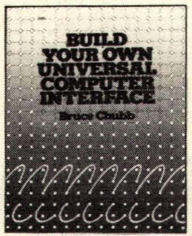
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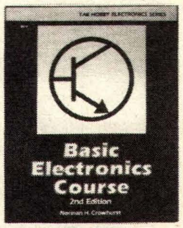
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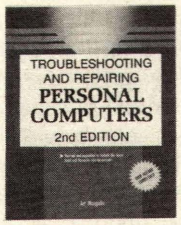
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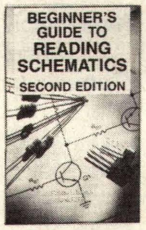
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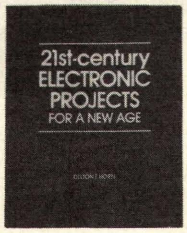
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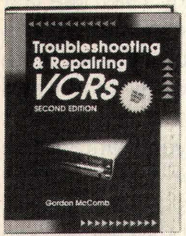
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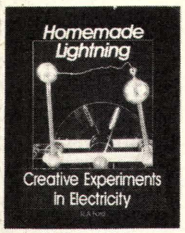
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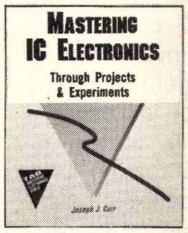
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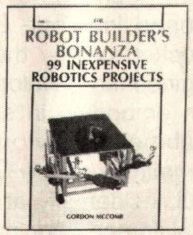
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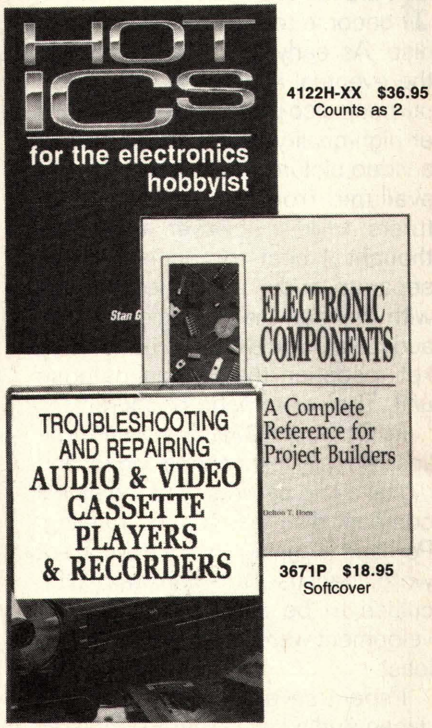
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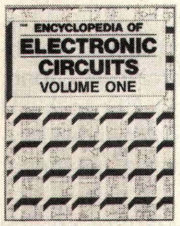
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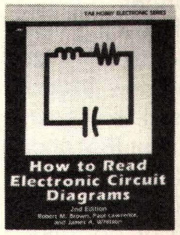
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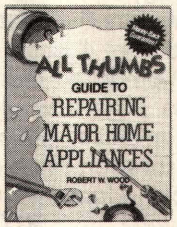
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AUDIO UPDATE

The CD Decade

LARRY KLEIN

In the late 1970's, Philips was hard at work on what was to become today's digital compact disc. As early as 1974, I predicted the eventual appearance of a dual-purpose disc player that could deliver high-quality digital sound and/or a video picture. Such units are now available from several manufacturers. Philips, however, apparently thought it best to concentrate on separate audio and video players with the idea that a single-purpose audio disc would enjoy a better market reception than a dual-purpose unit. They were right, of course.

In October 1979, Sony and Philips formally exchanged video and digital-audio patents, and the digital compact disc was off and running. Perhaps "running" is not the correct word, because the hardware difficulties to be overcome in its development were daunting, to say the least.

I spent several days at the 1981 Japan Audio Fair in Tokyo during my sixth not-quite-annual visit to Japan. In 1981, no less than 20 companies displayed CD players, but only a half dozen or so were actual working models. The rest were either units that the manufacturers couldn't get functioning in time for the show or simply empty shells demonstrating their interest and good intentions to produce players.

On a previous visit, I had also discovered that the few working prototype CD players invariably were connected by a cable to an under-the-table, foot-locker size electronics package. The electronics required by the CD player simply could not fit into the cassette-deck size housing. In 1981 Sony provided the solution in the form of its recently developed large-scale integrated circuits for CD. The magnitude of Sony's development was evident in its "before and after" display. The "before" configuration included three PC boards, each approximately 12 × 5 inches, edge-to-edge with ICs. In the "after" version, each board had been condensed into one LSI chip. I was knocked out by the investment in engineering development time and yen embodied in such an accomplishment. Obviously, Sony was committed to the CD for the long haul. Incidentally, at the time the official agreed-upon name for the new format—in Japan, at least—was compact digital audio disc, or C-DAD, or simply DAD.

CD intro

The official CD introduction date was 1983. I must admit that I had mixed feelings about CD at the time. I was impressed by the technology and its potential, but appalled by the cost of development and what it would take to amortize it. I predicted that the new $1000-plus players would sell like crazy when first introduced, but that once the first-on-the-block, cost-no-object gadgeteers and audiophiles bought their 50,000 or so units, sales would tumble rapidly and take years, if ever, to recover.

In my analysis, I forgot two things. As I said earlier, Japanese companies, unlike most of their U.S. counterparts, are in for the long haul and are willing to cut prices substantially to move their products. They are willing to forego immediate profits for potential long-term gains. (Witness Sony's support of the Beta format years after it was clear that VHS was the winner.) And so, as CD-player sales fell, so did the prices.

For years, many U.S. industry experts, in personal conversation, agreed with my speculation that the Japanese were, at best, breaking even, or perhaps even losing money, on every CD player they sold.

Today the CD sales picture is far rosier, even considering the currently depressed global economic conditions. Worldwide, CD's have gone from zero sales in 1982 to over a billion discs sold by 1991, the last year for which international figures are available. In the U.S.—despite the strapped economic times and the flagging stereo equipment sales—the CD-player marketplace grew 22% last year to 407 million units. In other words, people are still buying players, and those who own them intend to keep feeding them. And, incidentally, last year, for the first time, CD's outsold pre-recorded cassettes.

Nonsaturation

According to the Electronics Industries Association (EIA), about 42% of U.S. homes have a CD player of some type. Pundits compare this unfavorably to the 80% U.S. VCR saturation, and the much higher rate of CD ownership in Japan. However, comparing CD to VCR sales in the U.S., and American buying habits to those of the Japanese, is truly pointless.

For the past 20 years or so, the U.S. hi-fi trade organizations have constantly bemoaned the statistics of U.S. hi-fi ownership compared to those of Japan. Even before video, car stereo, and computers competed for the U.S. discretionary consumer-electronics dollar, the estimated 65% of U.S. music equipment owners compared unfavorably with the 85% saturation in Japan. I have no data to back it up, but my guess is that the 65% U.S. figure included a high percentage of junk equipment, whereas the Japanese stereo owners mostly had quality gear.

Over the years I've been quizzed frequently by both Japanese and Americans as to the reasons for that 15% difference. My best answer is based on both social and economic factors. Almost all the major audio-equipment manufacturers in Japan also make household appliances, industrial equipment, medical electronics, and so forth. If a Japanese consumer is happy with his Hitachi rice cooker, vacuum cleaner, or washing machine, he is likely to seriously consider a Hitachi audio component. In other words, the brand names of audio-equipment manufacturers are a familiar part of Japanese life. Large Japanese industrial companies also encourage their employees with various savings plans and discount arrangements to invest in their "house brand" audio equipment. The result of all this has been the development of a large number of hard-core audiophiles plus a higher level of interest on the part of the general public.

CD costs

Unlike the situation with conventional record players where, by and large, the more you paid the better they got, even the cheapest CD players provide excellent quality. Player costs have probably come down about as low as they are going to get. I've seen units advertised for slightly over $100.

I still don't understand the economics of player pricing. They are not like memory ICs whose cost per unit falls radically with time and sales because the inherent "parts" cost is insignificant to start with. CD players are crammed with precision-made mechanical parts that, it seems to me, are going to continue to keep the prices from going any lower. I'm grateful—and so should the rest of you be—that the prices of CD players have fallen as far down as they have.

Disc prices, on the other hand, have not fallen significantly from the 1983 initial introductions at $15 to $20. Interestingly, during a 1981 report on a visit to Denon's Tokyo recording studio, I quoted an engineer who said that, unlike the situation with CD players, the cost of the disc itself would not come down substantially with time. However, considering the effects of inflation and the significant rise in the yen with respect to the dollar, CD's are now something of a bargain. At least, if sales figures are an accurate indication, the music listening public seems to think so.

In any case, Happy Tenth Birthday to the Digital Compact Disc—and long may it rotate. Ω

DIVERSITY ANTENNA

continued from page 39

pass filter and an oscilloscope. Five millivolts of the pilot subcarrier will ensure proper system operation.

Temporarily fasten the diversity circuit to the automobile dashboard with duct tape, but put a cardboard hood over the LED lamps so that they can be seen more easily in daylight. Take the system for a test drive. Ask a passenger to check the switching action by observing the three LEDs as you drive.

When you are satisfied that the diversity circuit works, mount it in under the dashboard where it cannot be seen by passengers in the front seat, but where you can see the illuminated LEDs by ducking your head down close to the seat. Because of the wide variations in the size and shape of the space available under automobile dashboards and the limited space available for mounting an electronics case, universal mounting directions cannot be given. After selecting an appropriate location where the input and output wires and cables are free of stress, you can clamp the package in position with an adhesive-backed plastic clamp, a strap that you fashion from plastic or light metal, or even duct tape.

Application precautions

It is possible that the diversity circuit will not work on automotive radio receivers that are more than about 20 years old because of their restricted audio bandwidth. Nevertheless, the prototype was tested on several different car radios with differing ages, and it worked satisfactorily on all of them. The circuit will work with most late-model stereo receivers because they typically have as much as 20-kHz audio bandwidth. Ω

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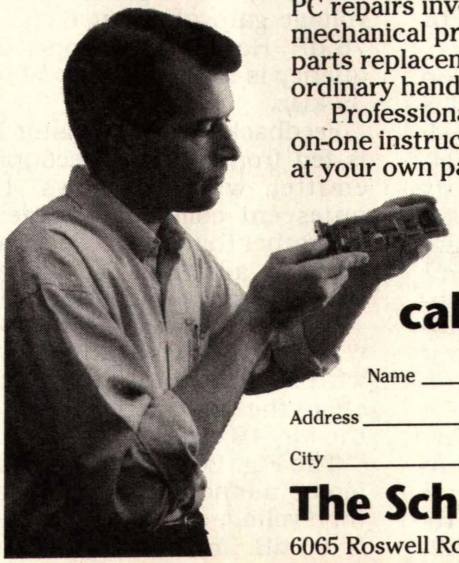

TRANSISTOR COOKBOOK

continued from page 72

across 5.6-kilohm emitter resistor R3. Because the emitter and collector currents of Q1 are approximately equal, the same voltage appears across 5.6-kilohm resistor R4. This sets Q1's collector at a quiescent value of two-thirds of the supply voltage. Emitter resistor R3 is AC-decoupled through C1, giving the circuit a voltage gain of 46 dB for AC signals.

Circuit variations

Figure 14 shows how the Fig. 13 circuit can be modified to give a fixed voltage gain of about 10. The operation of these circuits depends on a characteristic of common-emitter amplifiers: voltage gain equals the collector load-impedance value divided by the effective emitter-impedance value.

In Fig. 13, the effective emitter impedance equals that of the internal base-emitter junction; both equal 25 ohms at 1 milliampere. Thus this circuit has a voltage gain of about 200.

By contrast, in Fig. 14, resistor R3 is decoupled by series-connected capacitor C2 and resistor R5. Therefore, the AC emitter impedance equals the internal junction value in series with the equivalent parallel values of R3 and R5. This becomes about 560 ohms, yielding a voltage gain of about 10. Different gain values can be obtained by changing the value of R5.

Figure 15 is a simple variation of Fig. 14. In this circuit, R3 is not decoupled, and its impedance equals the value of R4. This gives the circuit a unity voltage gain. As a result, two unity-gain output signals are available: The collector output 1 is 180° out-of-phase with the input signal, but the emitter output 2 is in phase with the input signal. The circuit is called a *unity-gain phase-splitter.*

Figure 16, a variation of Fig. 11, offers 46 dB of voltage gain between the base and collector of Q1 but feedback biasing resistor R3 is AC-shunted by R2, giving the circuit a base impedance of about 500 ohms.

Resistor R1 is in series with the input signal and the base of Q1. As a result, R1 in conjunction with the 500-ohm base impedance, attenuates the signal between the Q1's input and base. The overall voltage gain of the circuit is about 10, or R2/R1.

Figure 17 shows how the circuit in Fig. 11 can be modified to give wideband performance by connecting direct-coupled Q2's emitter-follower stage between Q1's collector and the output terminal. Earlier, it was pointed out that the Fig. 11 circuit can have a theoretical maximum bandwidth of 1.5 MHz. Unfortunately, the shunting effect of stray output capacitance on R2 reduces that theoretical value to about 120 kHz. However, by buffering the output through Q2, these capacitive shunting effects can be reduced, and bandwidth can be extended to several hundred kilohertz.

High-gain circuits

A single-transistor common-emitter amplifier circuit cannot have a voltage gain that is significantly greater than 46 dB when it has a resistive collector load. If voltage gain higher than 46 dB is required, the circuit must have more than one transistor.

The circuit in Fig. 18 acts like a pair of direct-coupled common-emitter amplifiers. Transistor Q1's output is fed directly into Q2's base to give an overall voltage gain of about 6,150 or 76 dB. However, the upper frequency is limited to only about 35 kHz.

Feedback biasing resistor R4 is fed from Q2's AC-decoupled emitter, which "follows" the quiescent collector voltage of Q1, rather than Q1's collector directly. In addition, the bias circuit is effectively AC-decoupled.

Fig. 19 shows a alternative version of the circuit in Fig. 18 with an PNP output stage that offers the same performance as the Fig. 18 circuit.

The Fig. 20 circuit has a different method for obtaining a high voltage gain of about 2000 or 66 dB. Transistor Q1 is connected as a common-emitter amplifier with a split collector load of R2 and R3. Transistor Q2, connected as a common-collector amplifier or emitter follower, feeds the AC output signal from Q1's collector back to the junction of resistors R2 and R3 through capacitor C3.

This feedback *bootstraps* the value of resistor R3 (see last month's article) so that its acts as a near-infinite impedance to AC signals, and Q1 produces high voltage gain. The bandwidth of this circuit is only about 32 kHz, but its input impedance is only 330 ohms.

Other voltage amplifiers

Figure 21, for example, shows a common-base amplifier that offers wideband response. It is biased as shown in Fig. 13. However, in the Fig. 21 circuit, the base is AC-decoupled through C1, and the input signal is applied to the emitter through C3.

The circuit has a very low input impedance that equals the impedance of the forward-biased internal base-emitter junction. That impedance has the same voltage gain as the common-emitter amplifier (about 46 dB), and there is no phase shift between the input and output waveforms.

Figure 22 is a *differential* amplifier or "long-tailed" pair. The two transistors share the common-emitter resistor R7 (the "tail"), and the amplifier's bias point can be adjusted by trimmer potentiometer R8 so that identical collector currents are conducted in both transistors. That condition means that the collector voltages are equal under quiescent conditions.

Transistors Q1 and Q2 interact through R7, the emitter "tail." The output signals available from both collectors are proportional to the *difference* (the differential voltage) between the two input signals. Therefore, if identical signals are applied at the two inputs, the circuit has a zero output.

Figure 23 is the circuit of Fig. 22 modified to become a phase-splitter. It will provide two output signals 180° out-of-phase from a single-ended input.

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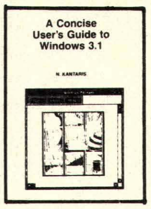

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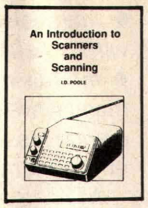

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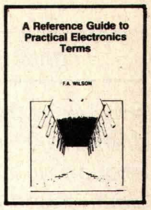

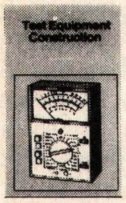

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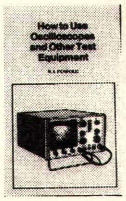

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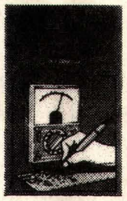

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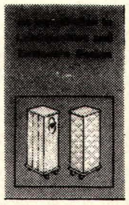

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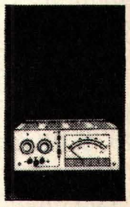

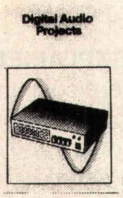

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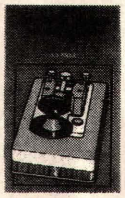

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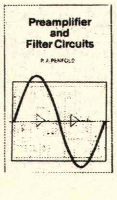

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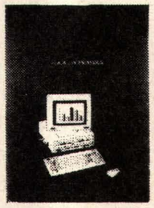

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LETTERS

continued from page 15

small (less than about four inches in diameter), there is usually not enough air motion to produce sufficient sound-pressure level at that low frequency, due to viscous losses for this small tube. The result is that the speaker response starts to roll off at the upper-frequency bump.

That characteristic certainly puts in doubt Mr. Freitag's comment that his speakers roll off at about 50 Hz with a cavity resonance 58 Hz—unless he has introduced input signal boost correction to offset that loss.

Freitag also says that rolloff below the cutoff frequency is 24, not 18, dB/octave. I'd like to direct him to page 244 of Acoustics, *by Leo L. Beranek (McGraw-Hill). I would also have him read Oluf Jacobsen's article "Some Aspects of the Self and Mutual Radiation Impedance Concept With Respect to Loud Speakers" in the* Journal of the Audio Engineering Society, Volume 23, No. 5.

On page 160 of Acoustical Engineering, *by Harry F. Olson (Van Nostrand), there is a response curve of a reflex enclosure with no input signal equalization, at about a 19-dB/octave rolloff below resonance. I believe it could possibly be steeper than that shown if the port-cavity resonance is pushed to a lower frequency.*

The efficiency of the reflex cabinet can be *a few dB higher at port resonance than a sealed enclosure if the port area is large enough. That occurs because the larger port area can develop significant sound pressure level with low losses, but only at the port-cavity resonance.*

The sealed enclosure is lossless at low-frequency resonance. Remember, the cavity is a reactance that stores energy, and the output is radiated into the surrounding air by the speaker. Nevertheless, Mr. Freitag is correct in saying that a ported system is susceptible to damage, particularly at the very low frequencies.

To sum up, the low-frequency resonance (and cutoff) of the sealed-enclosure speaker system can be lowered by:

- *Increasing the enclosure volume with no efficiency loss,*
- *Increasing the speaker's moving mass while accepting its loss in efficiency less above the cavity-speaker resonance.*

Making a reflex cabinet larger or its port area smaller (and/or longer) will lower the port-cavity resonance. That resonance can be tuned below the speaker resonance to obtain lower output frequency. However, that port, in effect, looks like another speaker trying to radiate at those low frequencies. If it's too small, it can't generate any sound pressure level.—Dale B. Blackwell

COMBUSTIBLE GAS ALARM WARNING

The article "Combustible Gas Alarm" (**Electronics Now**, July 1993) was published with a warning disclaimer. That warning must be taken seriously. It's likely that anyone who would build that alarm has an actual or potential problem with combustible gas. My concern is that the reader will expect the alarm to operate reliably. The article text only discussed the sensor theory and its ability to detect various combustible gases in generalities.

My introduction to gas sensors took place when I worked as a product development engineer 20 years ago. I was assigned to the development of a reliable combustible gas alarm based on the TGS combustible-gas sensor, manufactured by Figaro Engineering Inc. of Japan.

At that time, several different versions of the sensor were offered. Several seemed very attractive to me, but I was aware of a serious problem. If the sensor element (or parts of it) were insufficiently heated, it took a long time for the sensor to stabilize so that it would give a reliable reading.

However, even when it was heated long enough, its sensitivity to common combustible gases was not uniform. That characteristic caused false alarms in the presence of some weak gases, and there was no alarm in the presence of other gases at dangerously high levels of concentration.

However, if the semiconductor sensor element were overheated, it stabilized quickly and its senstitivity improved, but it had a useful life measurable in only tens of hours. Moreover, the sensor suffered permanent loss of sensitivity after a single exposure to an extremely high concentration of a combustible gas.

Since 1975, Figaro finally did what we pleaded unsuccessfully for it to do years earlier: It changed the sensor-heating method so that the entire element is now more nearly at a unifiform temperature. It's also possible that other improvements have been made.

The point is, satisfy yourself on a basis of performance tests before you rely on the Figaro TGS combustible-gas sensor. Also, investigate to determine if it has earned an acceptance label from any respected testing laboratory.

ALAN J. FISHER
Huntsville, AL

50-OHM TERMINATION EXPLAINED

In the May 1993 *Letters* column, Carl Ott asked what happens when a speaker termination of an audio amplifier is left open. He seemed to regard the possibility of damage to the amplifier as unlikely. That attitude seems to reflect his inexperience in these matters.

First, I agree that transistor amplifiers will not be damaged by an open termination. However, anyone whose experience goes back to the vacuum-tube era knows the reason why speaker terminals should not be left unconnected.

To enlighten Mr. Ott— and everyone else who has forgotten his electronic history, tubes are high-impedance devices. (That applies even to the high-current power tubes that were in amplifier output stages.) Because speakers have always been low-impedance devices, it was necessary to match the impedances of tubes and speakers.

The standard matching method made use of a transformer. To match the high-impedance tube end of the circuit, the primary winding of those transformers offered high-inductance windings. Consequently, changes of current (due to the signal that was to be amplified) through those windings would result in large voltage surges.

A speaker (or other suitable load) onnected to the secondary wind- gs of the transformer would ab- orb the associated surge energy, us limiting those voltages to a normal" value for that circuit.

If the output of the amplifier were ft unconnected, however, this in- uctive "kick" could build up to lev- ls that would damage the output ubes. The kick could also damage any of the passive components in e amplifier.

I find it surprising how close Mr. tt came to the truth in the rest of s excellent discussion about the eed for impedance matching. Yet e missed the key point!

OWARD MARK
uffern, NY

MISSING THOSE EQUATIONS

The article "Bipolar Tran- stors" by Ray Marston (**Elec- ronics Now**, September 1993) as interesting, but something was issing. In my opinion, as a retired chnician and electronic engineer, might have been of more value if r. Marston had included the basic quations needed to design the cir- uits shown in the article.

Way back in 1953, with no refer- nces available other than a book om Bell Laboratories, I designed a ree-transistor circuit for a Navy roject with only the appropriate quations and just a little bit of help om Thevinin's Theorem for sim- ifying networks.

I'm a World War II verteran who ent to Penn State. I worked for hilco Corporation three years be- re that company introduced its st consumer transistor radio back 1956. I think that your articles ould be more informative if you cluded the basic equations re- uired to design the circuits nown—as you did many years ago hen *Radio-Electronics* published e articles of Manny Horowitz.

TEVE KALISTA
m Thorpe, PA

ditor's reply: Marston's articles are tended to encourge experimenta- on by readers at all levels of experi- nce. As "cookbooks," they are not ubstitutes for circuit-design texts, they are intentionally non-mathe- atical. We hope you find them seful nontheless. Ω

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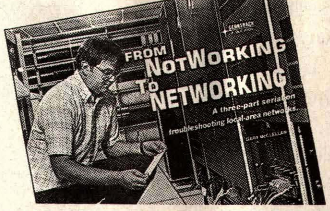
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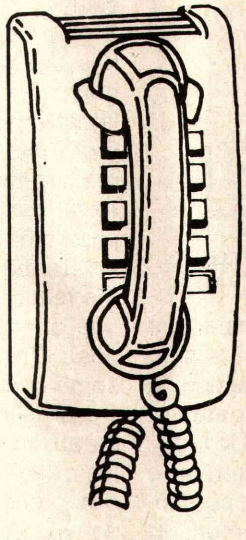

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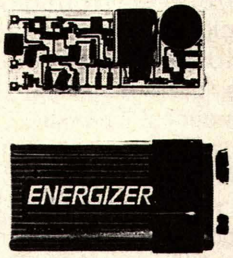

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NEW LITERATURE

continued from page 26

Troubleshooting and Repairing
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Homer L. Davidson

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that occur in compact-disk players, cassette decks, portable radios, amplifiers, speakers, tuners, turntables, and telephone-answering machines.

This troubleshooting guide includes more than 500 informative photographs, circuit diagrams, and illustrations. Time-saving troubleshooting charts and audio case histories enhance the text. This second edition has been updated to cover the latest audio circuitry, components, and test instruments introduced to the market.

U.S. Consumer Electronics Industry in Review, 1993 Edition: Entertainment & Education, Yesterday, Today & Tomorrow. The Electronic Industries Association's Consumer Electronics Group (EIA/CEG), 2001 Pennsylvania Avenue N.W., Washington, DC 20006-1813; Phone: 202-457-8702; free (send a $1.44 stamped, self-addressed, 6 × 9-inch envelope.

This book from the Electronics Industries Association provides an in-depth review of the consumer-electronics market, commenting on its past and present, and venturing predictions about the future. It outlines and tracks growth trends, and presents such information as unit sales from manufacturers and dollar-volume sales.

The review is divided by product category and covers video and audio products, home information systems, personal electronics including computers, mobile electronics including Citizen Band and marine radio, home automation systems, and home security systems.

In each section, the products and their history are briefly described. This EIA book includes charts and graphs of sales statistics and estimated household penetration by electornic product type.

THE U.S. ELECTRONICS
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YESTERDAY TODAY & TOMORROW

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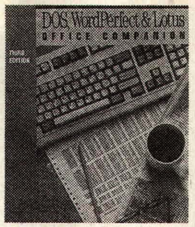
Special emphasis has been given to future trends, including closed captioning of TV, Radio Broadcast Data System (RBDS), digital electronics, alternative media, multimedia, personal computer-communication devices, and mobile electronics. The book also discusses the expected impact of Congressional legislation and FCC decisions on the consumer electronics market. Specifically mentioned are the Audio Home Recording Act and the cable re-regulation bill of 1992.

DOS, WordPerfect & Lotus Office Companion, Third Edition; by Robert W. Harris. Ventana Press, P. O. Box 2468, Chapel Hill, NC 27515; Phone: 919-942-0220; Fax: 919-942-1140; $21.95.



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This book explains how combining DOS, WordPerfect, and Lotus on desktop computers can save time, money, and desk space. Mr. Harris has condensed the essential features of the three programs into a three-part guide that teaches readers how to manage files and customize their systems for improved efficiency.

This edition of the book has been updated to account for changes in the latest versions of the three programs. The text leads readers through simple tutorial exercises on each program. It gives tips on mastering the mouse so the reader can speed end-use applications and bypass the more cumbersome commands.

Harris explains how to create macros and batch files, and tells you how you can profit from the latest software features such as MS-DOS's AntiVirus and improved backup, WordPerfect's graphics mode and multiple windows, and Lotus' SmartIcons.

The ARRL Radio Buyer's Sourcebook, Volume 2; edited by Bob Schetgen, KU7G. The American Radio Relay League, 225 Main Street, Newington, CT 06111; Phone: 203-666-1541; Fax: 203-665-7531; $15.

This sourcebook from the American Radio Relay league recaps advice on how to purchase amateur radio equipment taken from past issues of *QST* magazine. All of the advice is backed-up by laboratory test results. (*Volume 1* covers 1981 through 1991.)

After a discussion of the factors that will affect your choice of radio, the book discusses how amateur radios work, and then goes on to explain the characteristics of various models. Handy comparison charts make it easy to see just what features are offered on the different models, and performance charts provide ratings of the equipment reviewed in the book.

Radio Buyer's
Sourcebook
Volume 2

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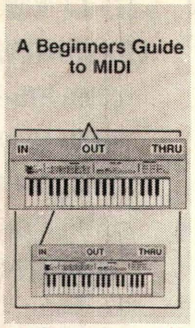
Also included are reviews of VHF/UHF fixed stations, VHF/UHF handheld transceivers, HF/VHF/UHF mobile transceivers, and dual-band handheld transceivers. Other topics include HF wattmeters, HF high-power amplifiers, an amateur TV system, and small-loop, vertical, and 10-meter beam antennas.

Appendixes list manufacturers' addresses and services, and references are made to all of *QST* magazine's product reviews from 1976 through 1992.

A Beginners Guide to MIDI; by R. A. Penfold. Electronics Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240; Order No. BP331; $6.25 plus $2.50 shipping.

This book is a primer for those with no previous ex-



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perience with the Musical Instrument Digital Interface (MIDI). Mr. Penfold says that neither an engineering background nor formal training in programming are essential for making effective use of MIDI. He says a basic understanding is all that is necessary to put together a system that works.

This guide explains how to exploit MIDI modes and channels for both "live" performances and sequencing. Other topics include basic MIDI timing and synchronization capabilities, and how to interpret a MIDI implementation chart.

Mr. Penfold explains the messages that communicate between the units in a system, and explains how to distinguish between MIDI messages that are worth exploiting and those that have no real value. Finally, he tells readers how to avoid problems with MIDI "choke," and how to troubleshoot minor circuit problems.

Surges, Sags, and Spikes: Protecting Your Personal Computer From Electrical Power Problems; by Mark Waller. Prompt Publications, 2647 Waterfront Parkway, East Drive, Indianapolis, IN 46214-2012; Phone: 800-428-7267 or 317-298-5710; Fax: 317-298-5604; $19.95.

Waller's book is intended

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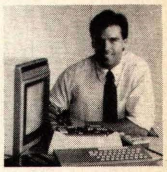

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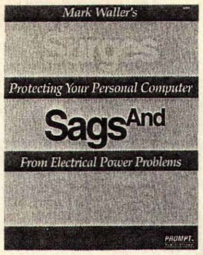
Mark Waller's
Protecting Your Personal Computer
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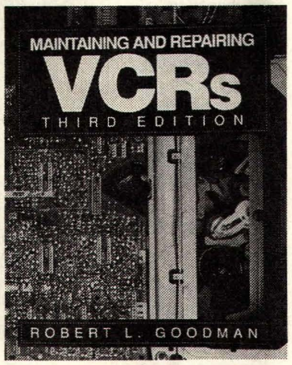
to help personal computer users protect their systems from a electrical surges, spikes, sags, brownouts, blackouts, and lightning. Utility-line disturbances can render a personal computer useless and wipe out its data in milliseconds—unless you're prepared.

This non-technical guide provides an overview of the available techniques and devices that will safeguard a computer from power-line disturbances. It starts off with an elementary lesson on electricity, and goes on to define power irregularities and explain how to overcome them.

Chapters explain the differences between AC-line power and the power needed for your computer. You'll also learn how to protect your PC from lightning strikes. Practical solutions are offered for static and noise interference. Descriptions are given for grounding techniques and many available devices: surge-suppressors, power-line conditioners, standby power sources, and uninterrupted power supplies. A full glossary and index are included.

Maintaining and Repairing VCR's: Third Edition; by Robert L. Goodman. TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Phone: 1-800-822-8138; $19.95.

A knowledge of how to repair your own video cassette recorder might pay off in money saving when you next experience trouble with your home unit. Goodman's book provides professional guidance in maintaing and repairing VCR's quickly and easily. This third edition, which has been completely updated and expanded, is packed with hundreds of helpful diagrams and photographs for guidance in locating and fixing VCR malfunctions.



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All of the information included in this book was gathered directly from the service departments of General Electric, Zenith, Sony, Panasonic, and other VCR manufacturers. The book contains detailed coverage of all the mechanical system, and electronic circuits in VCR's built to the VHS or Betamax standards. It describes test equipment suitable for troubleshooting VCR's. These include the new Sencore VC93 All Format VCR analyzer.

Chapters discuss camcorders and special VCR circuits such as high-quality (HQ) video and stereo audio circuitry. Procedures written in the form of case studies discuss common repairs made on popular VCR models to demonstrate problem analysis and solutions. The techniques can then be applied to other VCR's. Ω

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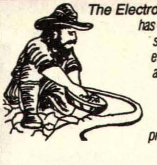

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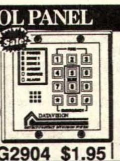

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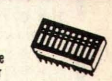

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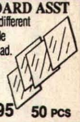

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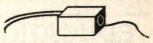

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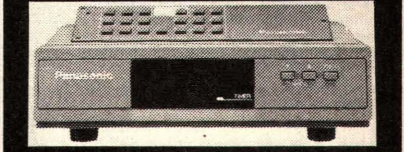

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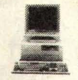

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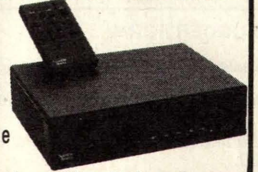

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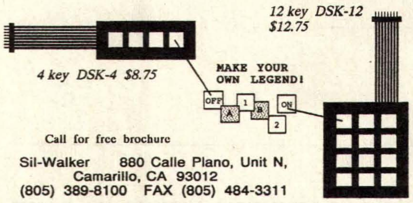

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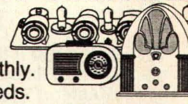

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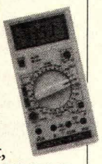
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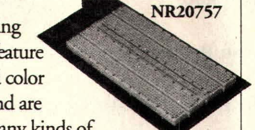
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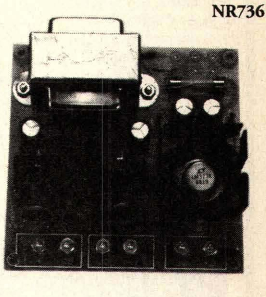
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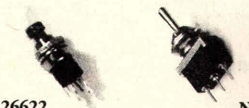
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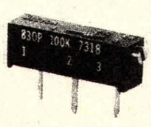

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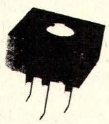

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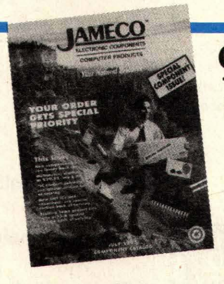

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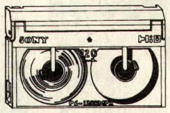

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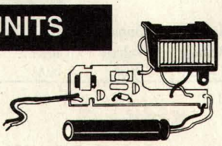

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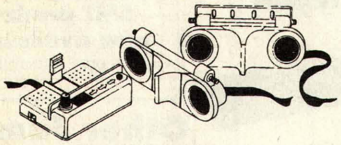

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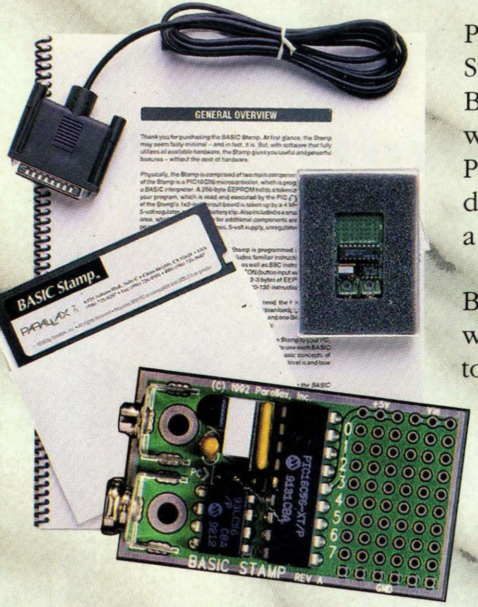

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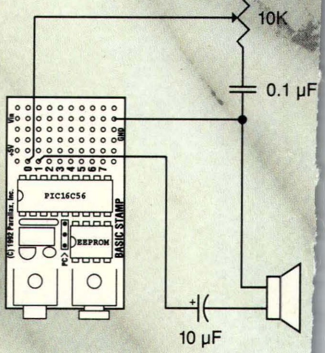

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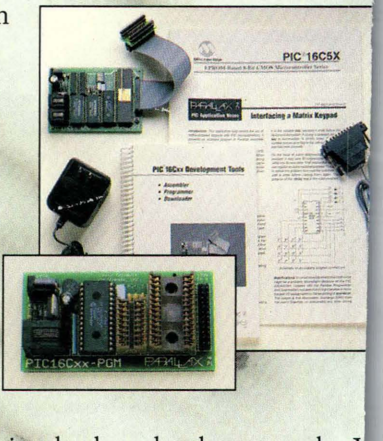

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